MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

Vol. XLIII SEPTEMBER-OCTOBER, 1951 No. 5

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[MYCOLOGIA for July–August (43: 389–465) was issued August 24, 1951.]

PUBLISHED BIMONTHLY FOR

THE NEW YORK BOTANICAL GARDEN

AT PRINCE AND LEMON STS., LANCASTER, PA.

Entered as second-class matter April 30, 1575, at the post office at Lancaster, Pa., under the Act of August 24, 1912.

MYCOLOGIA

Published by

THE NEW YORK BOTANICAL GARDEN

IN COLLABORATION WITH THE

MYCOLOGICAL SOCIETY OF AMERICA

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ALEXANDER H. SMITH

MYCOLOGIA

OFFICIAL ORGAN OF THE MYCOLOGICAL SOCIETY OF AMERICA

VOL. XLIII SEPTEMBER–OCTOBER, 1951 No. 5

THE NORTH AMERICAN SPECIES OF NAEMALOTOMA [1]

ALEXANDER H. SMITH [2]

(WITH 66 FIGURES)

INTRODUCTION

The genus *Naematoloma* was described by Karsten (**1879**) for the *Flammula*-like purple-brown-spored agarics which previously formed a part of the genus *Hypholoma*. He included *N. sublateritium, N. capnoides, N. epixanthum, N. fasciculare, N. aelopus, N. dispersum,* and *N. udum* with its varieties *Polytrichi* and *elongatum*. In the genus *Hypholoma* Karsten included *H. Buxbaumii, H. Prescoti, H. storea, H. lachrymabundum, H. velutinum, H. pyrotrichum, H. melantinum, H. cascum, H. coronatum, H. subpapillatum,* and *H. Candolleanum*. Karsten thus made a clear distinction between the two groups of species placed in *Hypholoma* by Kummer (**1871**) and Quélet (**1872**). To my knowledge he was the first author to make this clear distinction. This is important because, if one follows the International Rules, there can be no doubt as to the application of the names. *Naematoloma* is the valid name for the *Flummula*-like group whereas *Hypholoma* must be applied to the "fragile type" represented by *H. Candolleanum, H. storea,* etc., as mentioned above.

[1] Presidential address given at the Annual meeting of the Mycological Society of America, Columbus, Ohio, September 11, 1950.

[2] Papers from the Herbarium and the Department of Botany of the University of Michigan. Excess illustrations paid for by University of Michigan Herbarium.

[MYCOLOGIA for July–August (**43**: 389–465) was issued August 24, 1951]

The type species of *Naematoloma* is *Agaricus sublateritius* Fries (Epicresis Syst. Myc., p. 221). In Syst. Myc., Vol. 1, p. 288, Fries used the epithet *lateritius,* but since the same epithet had been previously used in the same work (p. 265) for a species of *Agaricus* in the tribe *Galera,* its second use is here regarded as invalid. Fries himself, as indicated, later made the change.

DEFINITION OF THE GENUS

Pileus variously colored but rather pliant to subcartilaginous in consistency, the pellicle of narrow appressed hyphae which may or may not gelatinize, depending on the species, and a hypoderm which is usually well differentiated, the pigments typically incrusting the hyphae and usually giving a bright yellow to orange-brown reaction as revived in KOH; lamellae adnexed to broadly adnate or subdecurrent, variously colored when young from pigment in cell sap as well as from incrusting pigments; stipe typically tough to cartilaginous, depending on thickness, ranging from ± 1 cm. to 1 mm. in thickness; partial veil present or absent, when present the fragments usually adhering to margin of pileus.

Spores fuscous-purple to dull cinnamon-brown in mass, when *revived in KOH* an almost uniform dull yellow-brown (dull ochraceous to dingy clay-color), spores thick-walled and with an apical germ pore which *usually* causes the apex to appear truncate; *pleurocystidia present as gloeocystidia,* hyaline when fresh and usually buried in the hymenium (hence, difficult to demonstrate) but when *revived in KOH readily seen because of a highly refractive, amorphous, irregularly shaped mass somewhere in the interior.*

AFFINITIES OF THE GENUS

Certain interesting features are brought to light when one compares the species of *Naematoloma* with those of other genera of purple-brown and black-spored agarics. It is evident at a glance that there is no close relationship between this genus and those placed in the Coprinaceae of modern European authors (see Smith **1950**). However, if the genera *Stropharia,*[3] *Psilocybe,*[3] and *Naematoloma* are compared, an interesting situation immediately comes

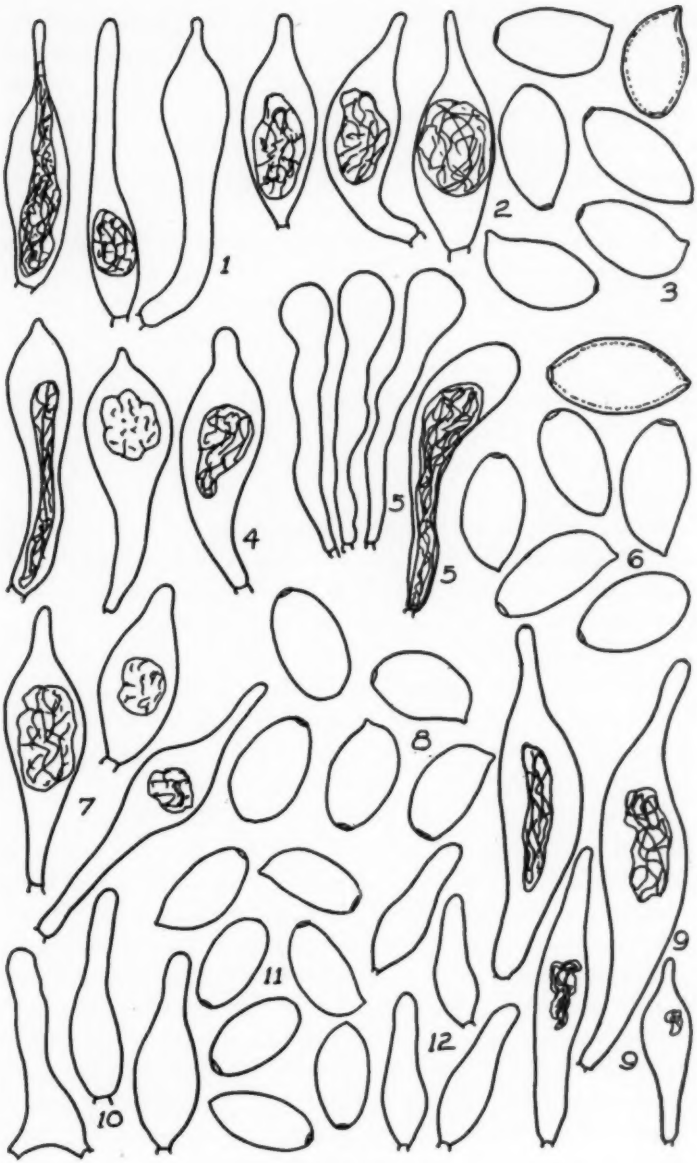
[3] For modern concepts of these genera see Smith (**1950**).

to light. It is evident to the casual observer that there is a strong similarity between them in regard to the general aspects of the fruiting body, such as consistency, kind of pigment, general coloration, etc., and this impression is found to have a solid basis when a detailed study of the microscopic characters is made. The spores in particular all change to yellow-brown in KOH, have thick walls and apical germ pores.

The classical distinction between *Strophoria* and *Naematoloma* is the presence of an annulus on the stipe in the former and its absence in the latter. This is not a fundamental character since a veil is present in both, but it serves conveniently to separate two populations of species which are separable if the aggregate of their secondary characters are considered. To put it another way, there is a distinctive *aspect* for each genus. The use of the annulus as a character breaks down when one considers the coprophilous species of *Stropharia,* but here the habitat is distinctive.

In the Friesian classification certain species now placed in *Naematoloma* are to be found in *Psilocybe* because of their slender stipes, which were described as *cartilaginous.* Karsten recognized that this character was not significant when he transferred *P. uda* to *Naematoloma,* and my own study of the character has served only to strengthen Karsten's conclusion. The brittleness of the stem varies inversely as the diameter—the thicker the stem the fleshier it is. Also in testing this character one must remember that the degree of turgidity plays a most important role.

Just as there is no truly fundamental set of characters to distinguish *Stropharia* from *Naematoloma,* we find, in comparing *Psilocybe* and *Naematoloma,* that they must be separated by an arbitrarily selected character if the two recognizable generic groups are to be maintained. All the species with a *Naematoloma*-aspect were found to possess the type of pleurocystidium previously mentioned (and for which I prefer to use the designation *naematolomoid type* of pleurocystidium rather than gloeocystidium) whereas in *Psilocybe* this type is absent. After demonstrating the constancy of this character is *Naematoloma,* it has been applied arbitrarily in my study of *Psilocybe* with the result that a few species with a *Psilocybe* aspect have been placed in *Naematoloma.* The species of *Stropharia* may or may not have the naematolomoid pleuro-



FIGS. 1–12.

cystidia and some species which possess them also have the usual hyaline fusoid ventricose type.

To me the natural affinities of these three genera are unquestionable, and they focus admirably on the problem of how, in a truly natural system, genera are to be delimited. The use of the presence or absence of naematolomoid pleurocystidia to separate *Naematoloma* from *Psilocybe* is a good example of the use, arbitrarily, of a single character in order to bring into better relief two distinct populations of species. That this same character breaks down when the third genus, *Stropharia,* is considered serves to emphasize that characters, useful in one set of circumstances, cannot be extended to all supposedly similar situations and given exactly the same value. The attempt to make such extended applications of characters, has, in my estimation, been the cause of a good share of the confusion one encounters in a study of the fleshy fungi. To me it is an accepted fact that between natural genera one will find intergrading taxa. It is the number of these, in relation to the number of species in each of the genera being compared, that is vital to the problem of whether two genera should be merged into one or a single genus divided into two or more genera.

The relationship of the *Naematoloma-Stropharia-Psilocybe* group to other agarics should also be mentioned. The resemblance of the fruiting bodies to those of the *Flammula-Pholiota* complex has long been recognized. The presence of scattered species in *Pholiota* (*sensu strictu*) having the naematolomoid type of pleurocystidium is considered significant here as is also the variation in the color of the spore deposit, which is quite dark in some, and it should be kept in mind that some brown-spored agarics are here placed in *Naematoloma*. The deciding difference when the color of the spore deposit is dull brown, actually, is whether or not the spores are somewhat truncate due to the presence of an apical germ pore.

The drawings of the spores, pleurocystidia and cheilocystidia were made with the aid of a camera-lucida. As reproduced the spores are magnified approximately × 1650, the pleurocystidia and cheilocystidia, × 750 with the exception of FIG. 37 which is × 450.

FIGS. 1–3, pleurocystidia and spores of *N. anomalum;* 4–6, pleurocystidia, cheilocystidia and spores of *N. viscidipes;* 7–8, pleurocystidia and spores of type of *Psilocybe elongatipes;* 9–11, pleurocystidia, cheilocystidia and spores of *N. olivaceotinctum;* 12, cheilocystidia of *Psathyrella petasiformis* (type).

A very narrow inconspicuous pore can be demonstrated in some species of the *Flammula-Pholiota* group, and I suspect that eventually an intergrading series will be established to connect the two groups. From my present information I would place *Naematoloma* and *Stropharia* as perhaps derived independently from *Pholiota* with *Psilocybe* derived in part from *Stropharia* and in part from *Naematoloma*. *Kuehneromyces* is a genus of rusty-brown-spored agarics, which, like *Psilocybe*, is distinguished from *Naematoloma* by the absence of naematolomoid pleurocystidia. All these genera, *Flammula, Pholiota, Naematoloma, Psilocybe, Kuehneromyces* and *Stropharia* were grouped in the family Strophariaceae by Singer and Smith (**1946**).

SPECIATION

Given a natural genus, what about the problem of delimiting species within it? Since very few "new" species are involved in this work it must be accepted that mycologists have been rather successful in delimiting taxa at the species level. The characters used are those in general use throughout the gill fungi, namely, spore size and shape, size and shape of the pleurocystidia, whether the hyphae of the pellicle gelatinize or not, size of carpophore (within broad limits), habitat to some extent, whether or not the stipe is viscid or dry, the colors of the pileus and gills, whether or not the stipe is furnished with a pseudorhiza, and odd features such as a peculiar color change when the flesh is bruised, or the presence of a distinctive odor or taste.

The point should be emphasized here that, although Fries and Karsten described the color of the spore deposit as belonging in the purple-brown series they actually included, on the basis of obvious relationship, taxa with cinnamon-brown spores. In this report the use of this character has been somewhat extended. It has not been used as a sectional difference, however, because the taxa which possess it appear to be more closely related to those with the typical spore color than to each other. Also, a large number of sterile and semi-sterile collections have been encountered in this genus and some interesting variations occur in connection with them. I suspect that such a poorly known species as *Agaricus epixanthus* of at least some European authors is merely a semi-

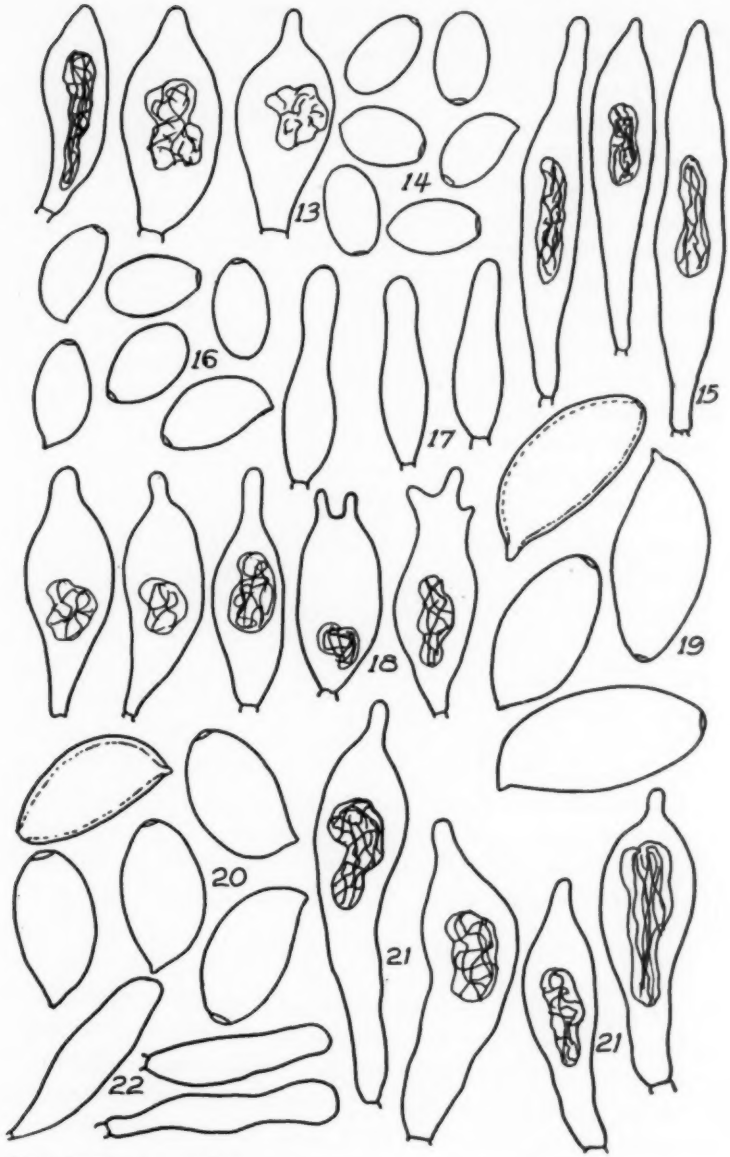
sterile form of *N. capnoides*. The characteristics of these forms are interesting. The yellow pigment in the gills, stipe, and cap may be greatly accentuated—enough to confuse one who has not collected extensively in the genus. Also, the degree of sterility varies and it appears that the color pattern of the fruiting body varies with the degree of sterility. Consequently, a long series of "variations" is to be expected. It also appears that the color of the fresh spores varies in these forms and no deposit, or only a thin one, can be obtained from some. These semi-sterile forms appear haphazardly in various species and to me indicate that the mycelia producing them are hybrids. The perennial nature of individual mycelia of this type has been established by the collection of the same semi-sterile "form" for a number of successive years around the same stump.

DISTRIBUTION

The genus is characteristic of the North Temperate regions, and most of the species are circumpolar. *N. olympianum*, *N. campestris*, *N. humidicola*, and *N. anomalum* appear to be endemic to North America. *N. viscidipes* has not been reported for Europe, but I suspect it occurs in Finland. No evaluation of the *Naematoloma* flora of tropical or south temperate regions can be made until more is known of agarics from those areas. As is true for many genera in the fleshy fungi, we have not yet reached the point where the known distribution pattern has much meaning. There are likely still other species of *Naematoloma* hiding in such genera as *Flammula*, *Naucoria*, *Psilocybe*, *Galerula*, *Conocybe*, etc., so this report is not to be considered final.

GENERAL COMMENTS

In the paragraph on material studied it should be kept in mind that no effort has been made to identify specimens as preserved in the various herbaria throughout the United States and Canada. I have, throughout the study, placed most emphasis on material collected in the fresh condition. With the concepts now arrived at, as presented here, one can go to herbaria and interpret the dried specimens with much more accuracy than was possible pre-



FIGS. 13–14, pleurocystidia and spores of *P. petasiformis;* 15–17, pleurocystidia, spores and cheilocystidia of *N. humidicola;* 18–19, pleurocystidia and spores of *N. Myosotis;* 20–22, spores, pleurocystidia and cheilocystidia of *N. udum.*

viously. The specimens listed have been cited in the briefest possible manner to conserve space. The plan followed is to list the collectors alphabetically, the states where they collected, and their collection numbers.

ACKNOWLEDGMENTS

The field work, carried on for the past fifteen years and upon which this paper is based, was made possible largely from grants received from the Faculty Research Fund administered through the Executive Board of the Horace H. Rackham School of Graduate Studies of the University of Michigan. In addition to this assistance it is a pleasure to acknowledge the support given by Mr. Wm. B. Gruber of Portland, Oregon. Both by means of financial aid and contributions of both his time and the use of his summer home near Mt. Hood, intensive investigations were carried on for three seasons in the central Cascade Mountains. It is a pleasure, also, to acknowledge the courtesies extended to us in the form of accommodations and other assistance at Mt. Rainier National Park during the season of 1948, by Mr. John C. Preston, Superintendent, and his entire staff. Dean L. R. Hesler of the University of Tennessee has contributed material from Tennessee and the Great Smoky Mountains National Park. It is through his efforts that the existence of *N. radicosum* in North America was clearly demonstrated. I am also indebted to the late H. D. House, of the New York State Museum, Albany, New York, for permission to study the types of species described by C. H. Peck, and to Dr. Fred J. Seaver, formerly in charge of the mycological collections of the New York Botanical Garden, for permission to study the types deposited there of species described by W. A. Murrill. The specimens cited, with the exception of the types of species described by Peck and Murrill, are all deposited in the University of Michigan Herbarium. The University of Michigan Herbarium has also stood the cost of the excess illustrations and pages.

NAEMATOLOMA Karsten, Bidr. Finl. Nat. Folk **32**: xxv. 1879.

Key to Sections

A. Typically gregarious; habitat typically terrestrial but often on peat or muck, sometimes on organic debris left by high water along streams..... Section *Tenacia*

A. Typically cespitose; habitat typically lignicolous or, if apparently terrestrial, the stipe furnished with a pseudorhiza (carpophores often present on sawdust, chipdirt, or soil containing much sawdust)..Section *Fascicularia*

Section Tenacia

Stipes typically long and slender, terrestrial though often on peat and muck in bogs, sometimes on lignicolous or herbaceous debris such as that left along streams after high water has receded. A few species have short stipes and the aspect of a typical *Psilocybe*.

Key to Species

1. Stipe viscid when fresh and moist.....2
1. Stipe always dry.....3
2. Spores 11–14 μ long; carpophore with the aspect of an *Inocybe*..... 1. *N. anomalum*
2. Spores 9–12 μ long, carpophore with the aspect of *N. udum*..... 2. *N. viscidipes*
3. Spores 13.5–18 μ long.....4
3. Spores smaller or up to 13.5 μ long.....6
4. Pleurocystidia often with proliferated apices, pellicle not gelatinous..... 3. *N. longisporum*
4. Pleurocystidia often with one or more obtuse projections; pellicle thick and gelatinous.....4. *N. Myosotis*
4. Pleurocystidia not as above.....5
5. Spores rusty-brown in mass; pileus citrine to olive-bronze young..... 4. *N. Myosotis*
5. Spores purple-brown in mass; pileus orange-tawny to ochraceous young.. 5. *N. udum*
6. Spores 11–13.5 × 7–8 μ.....6. *N. ericeum*
6. Spores smaller.....7
7. Spores 7–9 μ long.....8
7. Spores 9–11(–12) μ long, rarely over 6 μ broad.....9
8. Stipe 5–7 cm. long; pleurocystidia 40–60 μ long.....11. *N. Polytrichi*
8. Stipe 2–3 cm. long; pleurocystidia 26–34 μ long.....12. *N. campestris*
9. Stipe 1–2 cm. long; spores slightly flattened.....13. *N. Potteri*
9. Not as above.....10
10. Lamellae becoming dark purple-brown; (terrestrial forms of *N. dispersum* key here).....10. *N. squalidellum*
10. Lamellae dull sordid yellowish-brown to avellaneous at maturity.....11

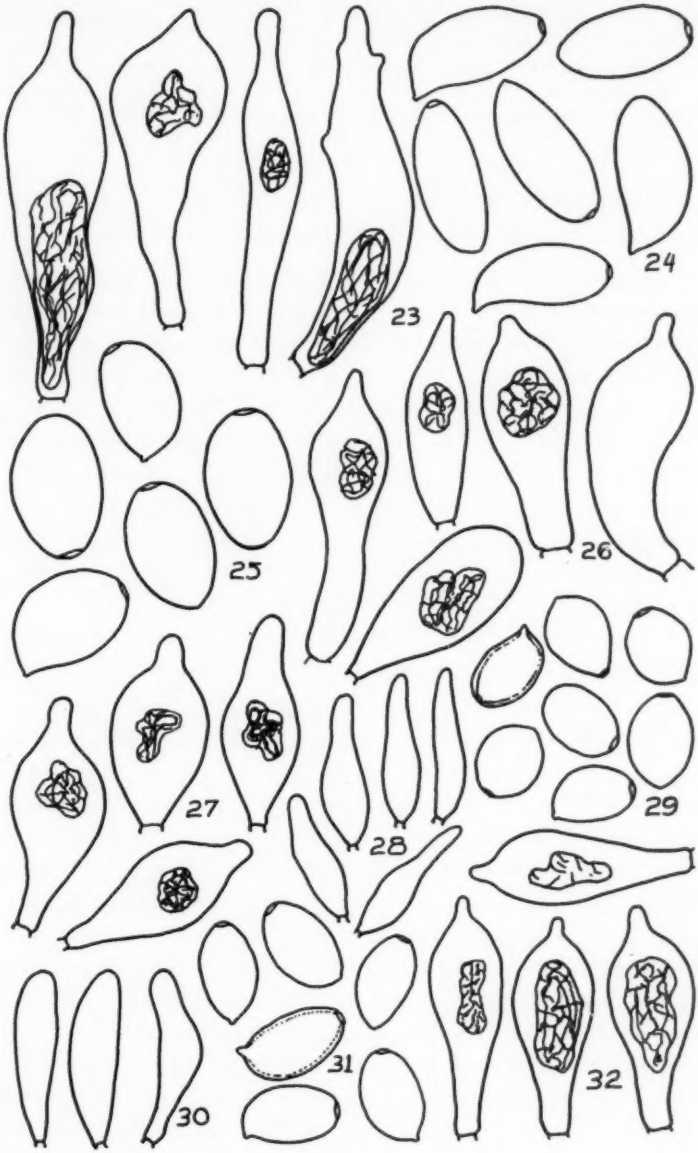
11. Pleurocystidia projecting 25–30 μ beyond the basidia....8. *N. humidicola*
11. Pleurocystidia not as above.....12
12. Spores narrowly ellipsoid; pleurocystidia of two sizes, 30–36 × 5–8 μ and 46–54 × 9–12 μ.....7. *N. olivaceotinctum*
12. Spores broadly subovoid; pleurocystidia rarely over 40 μ long.....9. *N. elongatum*

1. **Naematoloma anomalum** (Smith) comb. nov. FIGS. 1, 2, 3.
Hypholoma anomalum Smith, Mycologia **33**: 2. 1941.

Pileus 2 cm. broad, plane with an abrupt conic umbo and slightly decurved margin, surface glutinous, subrimose along the margin beneath the gluten, appearing finely appressed-fibrillose under a lens, disc "raw sienna," the remainder "ochre-yellow" (or bright rich yellow), when dried the disc "tawny" and the margin "amber-brown" (bright yellowish brown); flesh pale yellow, firm, odor and taste not distinctive; lamellae narrow, depressed-adnate, subdistant, equal, near "Isabella color," edges even; stipe 4.5 cm. long, 2.5 mm. thick, equal, glutinous over the lower two-thirds and orange-yellow, pale yellow and fibrillose-scurfy above, soon dry and appearing agglutinated-fibrillose under a lens.

Spores 11–14 × 5.5–7 μ, rusty-brown in deposit and pale cinnamon-brown under the microscope, furnished with an apical pore, smooth in KOH (in water-mounts of fresh material the exospore appeared slightly wrinkled); basidia four-spored; pleurocystidia and cheilocystidia abundant, sessile or with a thick, short, often curved pedicel, mucronate to subfusoid (similar in shape to those of *N. udum*), 35–50 × 6–12 μ, imbedded or projecting, yellow in water mounts of fresh material, hyaline or rusty-brown in KOH, usually with a highly refractive amorphous content, scattered cheilocystidia of the thin-walled saccate to fusoid type also present; gill trama with contorted highly refractive lactifers; pileus trama made up of a surface layer of innate hyphae 4–5 μ in diam., with their free portions gelatinous (not forming a typical separable pellicle), the hyphae arising from a compactly arranged highly colored but otherwise not differentiated hypoderm, the pigment incrusted on the cell walls, the remainder of the trama faintly yellowish and homogeneous, lactifers present, clamp connections abundant.

Habit, habitat and distribution: Solitary under rhododendrons,



FIGS. 23–24, pleurocystidia and spores of *N. longisporum;* 25–26, spores and pleurocystidia of *N. ericaceum;* 27–29, pleurocystidia, cheilocystidia and spores of *N. campestre;* 30–32, cheilocystidia, spores and pleurocystidia of *N. squalidellum.*

Great Smoky Mts. National Park, September. Known only from the type collection.

Observations: This species has so many distinguishing characters it would be difficult to confuse it with any of the others, though one might be tempted to search first for it in *Inocybe*. The combination of viscid pileus and stipe serve to distinguish it in the field from known members of that genus.

2. **Naematoloma viscidipes** (Smith) comb. nov. FIGS. 35, 36, 37.

Hypholoma viscidipes Smith, Mycologia **33**: 3. 1941.

Pileus 1–2 cm. broad, broadly conic, becoming campanulate, surface glabrous, viscid, opaque, margin incurved at first, color "cinnamon-brown" to "Sayal-brown" when moist, fading to "clay-color" or "cinnamon-buff" (dark to pale rusty brown and fading to pale buff or sordid yellowish brown, pale tan in dried specimens); flesh soft, rather thick, pallid watery brown, fading to buff, odor and taste not distinctive; lamellae bluntly adnate, developing a decurrent tooth, close to crowded (27–32 reach the stipe), 3–4 mm. broad, pale grayish when young, slowly becoming dull chocolate brown, edges white-fimbriate; stipe 7–10 cm. long, 2–2.5 mm. thick, equal, hollow, pliant, glutinous from a thin gelatinous layer (readily demonstrable under the microscope on mounts of fresh material), glabrous or appearing somewhat appressed-fibrillose beneath the gluten, arising from deep in the moss beds but no typical pseudorhiza evident.

Spores 9–12(–14) × 6–7 μ, ellipsoid, purple-brown in mass, sordid yellowish brown under the microscope when revived in KOH, smooth; basidia four-spored, 22–24 × 7.5–9 μ; pleurocystidia 35–60 × 6–10 μ, scattered, mucronate, fusoid-ventricose to clavate, content appearing granular in fresh material but when revived in KOH appearing as an irregular amorphous mass which is highly refractive; cheilocystidia very abundant, narrowly clavate to subcapitate, often flexuous, thin-walled, hyaline, 26–34 × 6–8 μ, gill trama regular and hyaline in KOH; pileus trama homogeneous beneath a gelatinous pellicle made up of hyphae about 2 μ in diam., the hyphae of the tramal body 8–9 μ in diam. and dark rusty brown

just beneath the pellicle, hyaline otherwise (revived in KOH), clamp connections present.

Habit, habitat and distribution: Solitary to scattered on moss, mostly *Polytrichum,* in an old burn in a bog. Known only from the type locality, Mud Lake Bog, Whitmore Lake, Washtenaw County, Mich.

Material studied: A. H. Smith, Michigan, *14945* (type), *18756, 20516.*

Observations: The stature of this species is more like that of *N. udum* than *N. ericaeum,* but the spores are more like those of the latter. From both it is distinguished by the truly viscid pileus and stipe. In dry weather, however, the viscidity on the stipe is soon gone and only a varnished appearance is indicative of the character.

3. **Naematoloma longisporum** (Murrill) comb. nov. FIGS. 23, 24.
Psilocybe longispora, Jour. Fla. Acad. Sci. **8**: 197. 1945.

Pileus 1.5–2.5 cm. broad, convex to plane, surface dry, glabrous, pale isabelline, smooth, becoming slightly striate to the disc, margin entire, concolorous; flesh very thin, white, unchanging, odorless, soon slightly bitter; lamellae emarginate with quite a broad adnate base, inserted, medium distant, 4–5 mm. broad, plane at first but becoming ventricose, brownish-mottled at maturity, edges white; stipe 4–5 cm. long, 1–2 mm. in diam., tapered downward, hollow, lightly furrowed, pallid and white-chaffy above, chestnut and glabrous below.

Spores 14–18 × 6.5–8 μ, somewhat inequilateral in side view, narrowly ovate in face view, smooth, ochraceous tawny in KOH, apical pore very small and inconspicuous; basidia 28–33 × 10–11 μ, four-spored, hyaline to pale yellow in KOH; pleurocystidia very abundant, 36–52 × 9–13 μ, clavate-mucronate, with a highly refractive central body when revived in KOH, many irregular in shape with apex proliferated or more than one proliferation present and these irregularly spaced, many with yellowish walls in KOH; cheilocystidia abundant, similar to pleurocystidia or merely fusoid-ventricose, 18–36 × 5–8 μ, content homogeneous, apices obtuse, gill trama parallel, pale yellow in KOH, the hyphae 6–11 μ

in diam., pileus trama with a very thin pellicle of non-gelatinous hyphae 2.5–4 μ in diam., yellow in KOH, layer 1–2 hyphae deep, beneath it a broad hypoderm of enlarged cells yellow in KOH, this layer 70–100 μ in diam., the remainder of flesh pale sulphur-yellow in KOH and compactly interwoven, hyphae 5–13 μ in diam., clamp connections present.

Habit, habitat and distribution: On vegetable debris in a dried up cypress pond, Cary Forest, near Gainesville, Fla.

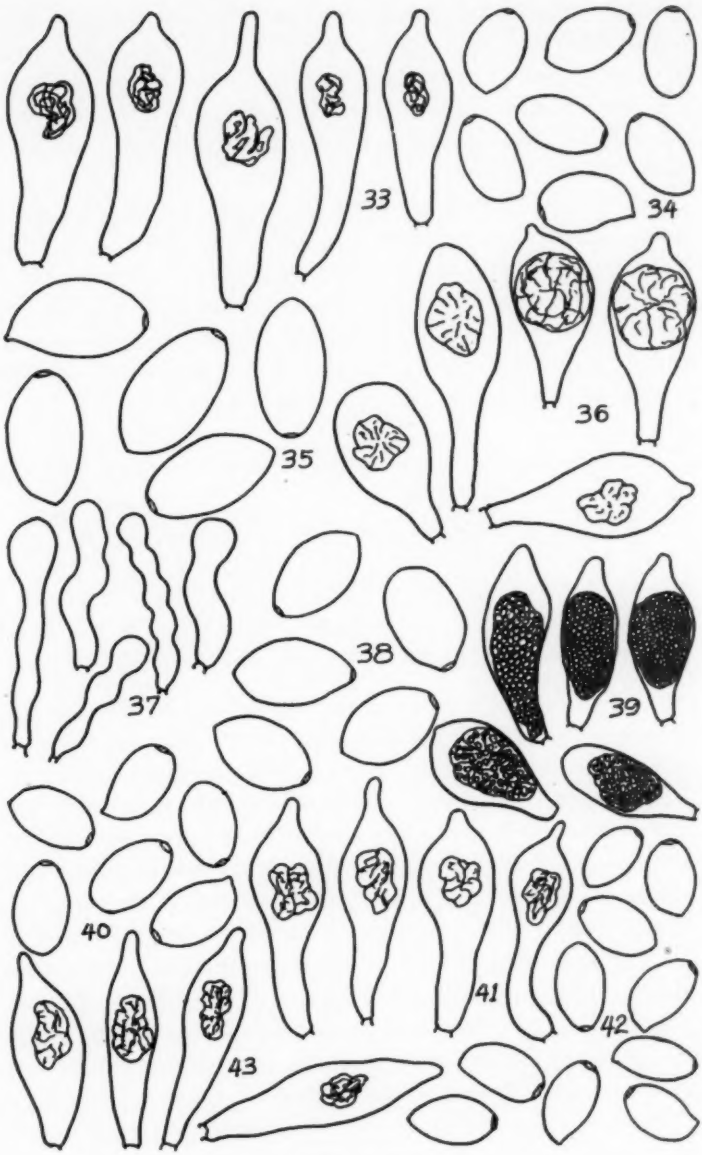
Observations: This species is closely related to *N. udum* but I have never observed the latter with pleurocystidia proliferated as in Murrill's plant. This in addition to the striking difference in habitat seem sufficient to recognize it. A portion of the type communicated by W. A. Murrill has been studied.

4. NAEMATOLOMA MYOSOTIS (Fries) Smith, Mycologia **42**: 323. 1950. FIGS. 18, 19, 66.

Agaricus Myosotis Fries, Syst. Myc. **1**: 290. 1821.
Naucoria Myosotis Kummer, Führer in die Pilzk. p. 77. 1871.
Hylophila Myosotis Quélet, Enchir. Fung. p. 102. 1886.
Agaricus elatior Peck, Ann. Rep. N. Y. State Mus. **39**: 41. 1887.
Naucoria elatior Saccardo, Syll. Fung. **9**: 109. 1891.

Pileus (10–)15–30(–40) mm. broad, broadly conic to convex, glabrous except occasionally with scattered veil remnants along the margin, edge often appendiculate, viscid to glutinous, evenly "medal-bronze" to "citrine" (olivaceous or greener), evenly colored, opaque when young but before fading becoming brownish and striatulate, near olive-buff faded; flesh dull-greenish, pliant, odor and taste not distinctive; lamellae adnate to shallowly adnexed, equal to slightly ventricose, subdistant, broad, whitish at first, then pale olivaceous and finally brown from the spores, edges minutely white-fimbriate and eroded; stipe (6–)10–15(–20) cm. long, (2–)3–7 mm. thick, very rigid, equal, hollow, covered to the line formed by the broken veil by white to olivaceous veil fibrils in patches or zones, densely pruinose above.

Spores 14–17 × 7–9 μ, narrowly inequilateral in side view, narrowly ovate in face view, ochraceous-tawny in KOH and smooth to very slightly wrinkled (as revived in KOH), the wall relatively



FIGS. 33–43.

thick, apical pore present but apex not truly truncate; basidia four-spored, projecting when sporulating, hyaline in KOH, 26–34 × 9–11 μ; pleurocystidia present, 35–46 × 10–13 μ, ventricose-mucronate or with several protuberances over upper portion, some ventricose with broadly rounded apices, hyaline and homogeneous in water mounts fresh, with a highly refractive amorphous content variously disposed as revived in KOH; cheilocystidia abundant, 32–46 × (6–)8–12 μ, the broadest cells usually with highly refractive content, narrowly ventricose and apices obtuse, thin-walled, gill trama subparallel, olivaceous to yellow in KOH; pileus trama with a well-differentiated gelatinous pellicle of hyphae 3–5 μ in diam., cells beneath much larger and yellow in KOH (content olivaceous fresh), clamp connections present.

Habit, habitat and distribution: Gregarious on wet humus along edges of bogs, late summer and fall. It is typically northern in its distribution, and is not rare during some seasons. I have seen it most abundantly during rather dry weather.

Material studied: Peck's type of *Naucoria elatior:* A. H. Smith, New York, Ontario, Michigan and Washington, *207, 334, 371, 604, 988, 2596, 4015, 4319, 15483.*

Observations: The olive to olive-brown viscid pileus, the yellow-brown color of the spore deposit, and large spores are a very distinctive combination of characters. The slight irregularity in the spore wall of *N. Myosotis* and *N. udum* is an important taxonomic character but one likely to be overlooked by most people.

5. NAEMATOLOMA UDUM (Pers. ex Fr.) Karsten, Bidr. Finl. Nat. Folk **32**: 497. 1879. FIGS. 20, 21, 22, 56, 64, 65.

Agaricus udus Fries, Syst. Myc. **1**: 292. 1821.

Coprinarius udus Kummer, Führer in die Pilzk. p. 69. 1871.

Hypholoma udum Quélet, Champ. Jura et Vosges Sup. **4**: 328. 1876.

Psilocybe uda Gillet, Les Hymén. p. 586. 1878.

FIGS. 33–34, pleurocystidia and spores of *N. Polytrichi;* 35–37, spores, pleurocystidia (× 750), and cheilocystidia (× 450) of *N. viscidipes;* 38–39, spores and pleurocystidia of *N. Potteri;* 40–41, spores and pleurocystidia of *N. dispersum;* 42–43, spores and pleurocystidia of *N. capnoides.*

Geophila uda Quélet, Enchir. Fung. p. 114. 1886.
Dryophila uda Quélet, Fl. Myc. Fr. p. 153. 1888.
Psilocybe squalidella var. *macrosperma* Peck, N. Y. State Mus. Bull. **157**: 98. 1912.
Psilocybe squalidella var. *deformata* Peck, N. Y. State Mus. Bull. **157**: 98. 1912.

Pileus 1–3(5) cm. broad, obtusely conic to convex when young, the margin usually slightly incurved, becoming broadly convex or plane, sometimes slightly umbonate, surface moist, lubricous when wet, at first with scattered superficial fibrils along the margin from the almost rudimentary partial veil, soon glabrescent, often entirely glabrous from the beginning, somewhat hygrophanous, color extremely variable, when young pale or dark rusty brown, becoming yellowish brown and finally fading to pale yellow or buff, water-soaked specimens frequently dark purplish brown tinged with olive ("ferruginous," "orange-cinnamon," "tawny" or "sudan-brown" when fresh and moist, fading to "baryta-yellow," "light orange-yellow" or "pale ochraceous-salmon" and in age finally becoming "Isabella-color"); flesh thick under the disc, pliant, yellowish, odor none or not distinctive, taste slightly bitterish; lamellae bluntly adnate, close to subdistant, broad, whitish to "cream-buff" or "chamois" (pale yellowish) at first, soon sordid purplish-brown from the spores but olive-yellow tints frequently persisting, edges whitish; stipe 4–12 cm. long, 1.5–4 mm. thick, equal, cartilaginous, tubular, "ferruginous" to "russet" (dark rusty brown) below, pale yellowish above or occasionally whitish, surface with scattered patches of appressed fibrils from the remains of the poorly developed partial veil, glabrescent.

Spores 14–18(–20) × 5–7 μ, with a very small apical germ pore (use oil-immersion), appearing smooth under ordinary dry magnifications but under oil appearing punctate, narrowly ellipsoid to slightly inequilateral or the midportion slightly ventricose, bright purplish brown under the microscope fresh, sordid yellow-brown revived in KOH; basidia four-spored; pleurocystidia 30–50 × 8–12 μ, broadly fusoid to mucronate, with a highly refractive content when revived in KOH; cheilocystidia 25–37 × 7–10 μ, filamentose, fusoid-ventricose or subcapitate, thin-walled, hyaline, usually form-

ing a broad sterile band on the gill edge; gill trama subparallel to interwoven, yellow revived in KOH, pileus trama characterized by a poorly organized pellicle, a well developed hypoderm of enlarged cells (10–18 μ in diam.), and a tramal body of interwoven hyphae 6–12 μ in diam., dull orange to yellowish in KOH, clamp connections present.

Habit, habitat and distribution: Scattered to gregarious in sphagnum bogs or wet humus in conifer forests; late summer and fall. It is often the commonest species in bogs in late August after hot dry summers. In bogs in southern Michigan it is frequently found in rabbit runways in and near the margins of bogs.

Material studied: E. Halfert, Cass County, Mich. 1947: L. R. Hesler, Clingman's Dome, Great Smoky Mts. National Park, *14037;* A. H. Smith, New York, Ontario and Michigan, *33–617, 33–1013, 33–1029, 33–1039, 205, 258, 258a, 598, 630, 633, 4042, 4262, 4926, 6127, 7592, 7692, 11026, 31901, 33562* and 4 unnumbered collections from Michigan, 1929.

Observations: It is impossible to be sure, in the field, that one has this species because it intergrades so in macroscopic characters with *N. squalidellum* and others of the section. It is small wonder that Peck was tempted to name it as a variety of *N. squalidellum.*

6. **Naematoloma ericaeum** (Pers. ex Fries) comb. nov. FIGS. 25, 26.

Agaricus ericaeus Pers. ex Fries, Syst. Myc. **1**: 291. 1821.
Coprinarius ericaeus Kummer, Führer in die Pilzk. p. 69. 1871.
Psilocybe ericaea Quélet, Champ. Jura et Vosges Pt. II, p. 349. 1873.
Geophila ericaea Quélet, Enchir. Fung. p. 114. 1886.
Stropharia subumbonatescens Murrill, Mycologia **33**: 280. 1941.

Pileus (12–)15–30(–60) mm. broad, ovoid to ellipsoid in button stages, the margin appressed against the stipe, expanding to obtusely conic, conic-campanulate or finally nearly plane with only a papillate umbo or umbo obsolete and disc slightly depressed, surface glabrous except for fibrillose remains of the veil along the margin at first, surface viscid to subviscid when moist but soon dry, color variable "buffy-brown" to "olive-brown" on margin and



FIGS. 44–58.

"tawny" on disc, hygrophanous and fading to near "pale pinkish-buff" and finally near "ochraceous-buff" or "yellow-ocher," sometimes "Mars yellow" on disc, becoming pale cinnamon-brown in drying; flesh pale yellow to whitish-creamy, taste mild or raphanoid, at times becoming slightly astringent, odor weak and slightly raphanoid; lamellae rounded-adnate becoming sinuate to adnexed, at times finally seceding, moderately close to subdistant, broad and ventricose, pallid to grayish becoming deep purplish gray to almost black, edges pallid, becoming eroded; stipe 4–8(–13) cm. long, 2.5–4(–10) mm. thick, tapering either way but usually subequal, solid, but with a distinct rigid cortical layer, "buffy-brown," "snuff-brown" or "sepia" when young, becoming white to "cartridge-buff" near apex and "cream-buff" below, finally "chamois" to "honey-yellow" or even "Isabella-color" in large specimens, base usually curved and pure white from mycelium, surface above with pallid fibrils, usually with a superior fibrillose zone from the remnants of the veil, no distinct annulus.

Spores 11–13.5 × 6.5–8 μ, purple-brown in deposits, dull yellow-brown in KOH, ellipsoid to subovoid, apex appearing truncate because of an apical hyaline lens-shaped pore, otherwise thick-walled, the wall 1–1.5 μ in diameter; basidia four-spored, hyaline in KOH, 30–34 × (7–)8–10 μ; pleurocystidia abundant, fusoid-ventricose to mucronate (28–)37–54 × 8–14 μ, with a yellowish highly refractive amorphous body in broadest portion (most easily demonstrated when material is revived in KOH); cheilocystidia abundant and forming a sterile band on the gill edge, fusoid-ventricose to subcylindric, apex rounded but subacute, 24–34 × 5–9 μ, content hyaline and homogeneous when mounted in KOH; gill trama parallel, dull yellowish-brown in KOH, near argus-brown next to subhymenium, the hyphal cells cylindric and 5–8 μ in diam.; pileus trama with a very thin gelatinous pellicle of hyphae 2.5–3 μ in diam., this region gradually grading into the

FIGS. 44–45, pleurocystidia and spores of *N. subochraceum;* 46–47; pleurocystidia and spores of *N. fasciculare;* 48–49, pleurocystidia (2 partly collapsed) and spores of *N. radicosum;* 50–51, pleurocystidia and spores of *N. olympianum;* 52–53, pleurocystidia and spores of *N. sublateritium;* 54–55, pleurocystidia and spores of *Hypholoma flavovirens* (type); 56, spores of *Psilocybe squalidella* var. *macrospora* (type); 57–58, spores and pleurocystidia of *P. squalidella* var. *cespitosa.*

interwoven paler flesh which has hyphae 5–10(–12) μ in diam., clamp connections present.

Habit, habitat and distribution: Scattered to gregarious on grassy wet soil along the edges of ponds or on low moist ground in open grassy woods of pine, along old roads, etc.

Material studied: R. P. Burke, Alabama, *2043;* F. S. Earle, Alabama (*Stropharia subumbonatescens* Murr.) 1 collection; L. R. Hesler, Tennessee, *18289;* M. B. Walters, Ohio, 4 collections.

Observations: The slightly viscid pileus, spore size and generally more robust stature distinguish this species from the two preceding ones. It is a very rare fungus in North America.

7. **Naematoloma olivaceotinctum** (Kauffman) comb. nov. FIGS. 9, 10, 11.

Psilocybe olivaceotincta Kauffman, Pap. Mich. Acad. Sci. **5**: 144: 1926.

Pileus 1.5–3 cm. broad, at first obtusely campanulate, then expanded plane, hygrophanous, "citrine-drab" (dull green) and faintly striatulate moist, "olive-buff" to "pinkish buff" and atomate when dry, glabrous, margin at first incurved; flesh thin, concolorous with surface, fragile, odor and taste not distinctive; lamellae broadly adnate, close to subdistant, thin, rather broad, at first "pale olive-buff" (pale olive-gray), then "citrine-drab," edge entire; stipe 3–5 cm. long, 1.5–2.5 mm. thick, equal or tapering downward, toughish, becoming rigid-brittle, "cinnamon-rufous" (bright reddish-brown) upward, "chestnut-brown" (chestnut-color) downward, glabrous, apex minutely scurfy at times, tubular.

Spores 9–12 × 4.5–5.5(–6) μ, smooth, narrowly ellipsoid to subventricose at the base and tapered to the rounded apex, purplish brown under the microscope in water mounts, pale tawny when revived in KOH, apical pore present but inconspicuous; basidia 30–34 × 5–6 μ, narrowly clavate to cylindric, hyaline to pale yellow in KOH (hymenium in sections bright-yellow-orange when poorly dried material is revived), four-spored; pleurocystidia present, 30–36 × 5–8 μ, subaciculate to narrowly mucronate or fusoid and with highly refractive content, imbedded in the hymenium, some 46–54 × 9–12 μ, clavate-mucronate, bright orange

in KOH and arising in the subhymenium; cheilocystidia hyaline in KOH, 22–34 × 5–9(–10) μ, cylindric to fusoid-ventricose, the neck flexuous and apex subacute, content homogeneous or refractive, some also occurring on faces of gills near edge; gill trama parallel to somewhat interwoven, the cells short and broad (often ± 40 × 20 μ), more elongated near subhymenium, pale yellow in KOH; pileus trama with a cuticle of narrow appressed (3–5 μ in diam.) hyphae, beneath this a hypoderm of vesiculose bright yellow (in KOH) cells two or three cells deep, tissue beneath hypoderm floccose and bright or pale yellow, clamp connections present.

Habit, habitat and distribution: Gregarious to scattered on rich humus and on debris, often along the outwash of streams, in conifer forests. I have seen collections from Oregon, Washington and New York. It fruits in the late summer and fall and appears to be rare.

Material studied: H. A. Imshaug, Washington, *988, 1112;* Kauffman's type of *Psilocybe olivaceotincta;* C. H. Peck, New York, one collection from a swamp, Forestburgh; A. H. Smith, Washington and Oregon, *16597, 16735, 24472, 26845.*

Observations: This species can be distinguished microscopically by the extreme variability of the pleurocystidia. I have seen it fresh around Mt. Hood and have been able to recognize it in the field there by the color of the pileus. However, most of the slender-stiped species tend to develop olivaceous colors, and so the cap color may turn out to be unreliable under some conditions.

8. NAEMATOLOMA HUMIDICOLA (Murrill) Smith, Mycologia **40**: 693. 1948. FIGS. 15, 16, 17.

Naucoria humidicola Murrill, North Amer. Flora **10**: 174. 1917.

Pileus 10–20 mm. broad, obtuse to convex when young, expanding to plane or broadly convex, the margin remaining decurved, surface glabrous, moist, "Sayal-brown" to orange-tawny on disc, margin ochraceous, gradually becoming paler and in age "Isabella-color" over all or margin more olivaceous; flesh thin, pliant, sordid yellowish, odor none; lamellae broadly adnate and in age with a decurrent tooth, subdistant, very broad, pallid to sordid yellowish, becoming sordid tawny when dried, edges white-fimbriate but

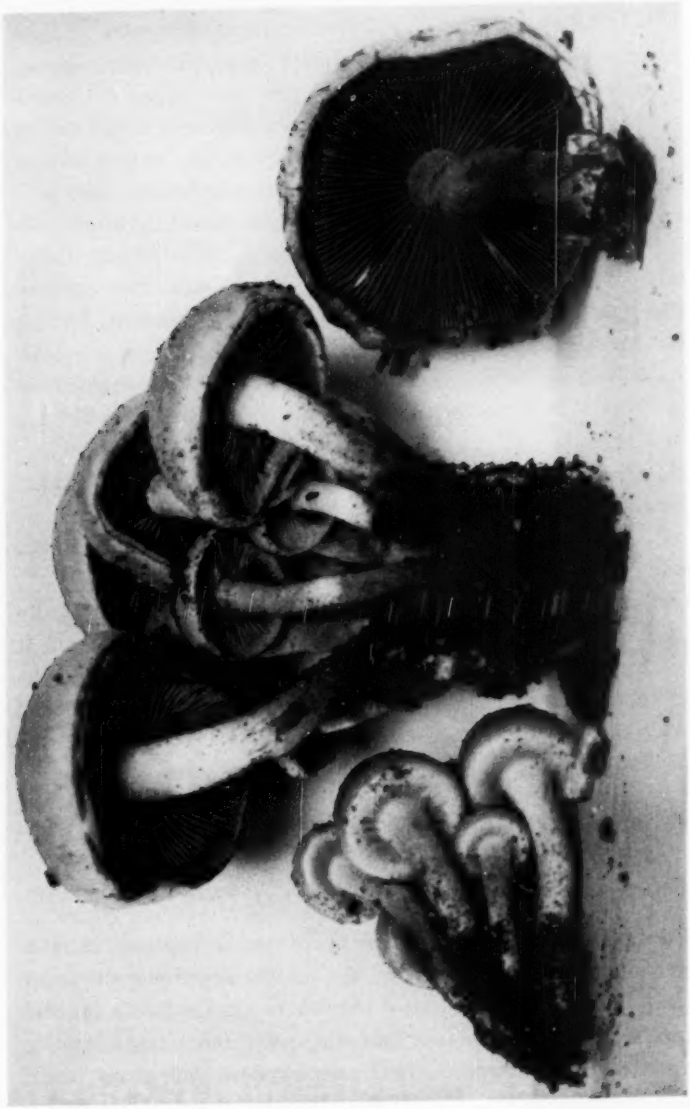


FIG. 59. *Naematoloma sublateritium* (Fr.) Karsten × 1.

even; stipe 4–6 cm. long, 1.5–2.5 mm. thick, equal, cartilaginous, "Sayal-brown" or darker below, pallid sordid yellowish above, slightly appressed-fibrillose to glabrous, apex pruinose, surface merely moist when fresh, base surrounded by white mycelium.

Spores 9–11 × 5.5–6.3 μ, ovoid in front or back view, elliptic to slightly inequilateral in side view, pale tawny in KOH, smooth, apical pore present but very indistinct; basidia hyaline to pale yellow in KOH, four-spored, subcylindric, 23–27 × 5–6.5 μ; pleurocystidia scattered, yellow in KOH, fusoid-ventricose to subclavate-mucronate (44–)50–58(–64) × 8–10(–12) μ, usually with highly refractive content or what appears to be a wrinkled inner wall, projecting 25–30 μ beyond the basidia; cheilocystidia 24–28(–32) × 5–8 μ, ventricose to subcylindric, hyaline, content homogeneous, thin-walled, abundant; gill trama subparallel, the cells equal in width throughout their length, pale yellow in KOH, subhymenium cellular but very thin and indistinct, pileus trama with a thin pellicle of narrow gelatinous hyphae 2.5–4 μ in diam., beneath it a hypoderm of enlarged cells, the remainder filamentose and floccose, all parts pale yellow in KOH, clamp connections present.

Habit, habitat, and distribution: Solitary to scattered on moss in conifer forests, New York, Washington and Oregon. It is a rare species which so far has been found in the fall.

Material studied: Murrill's type of *Naucoria humidicola;* H. A. Imshaug, Washington, *987, 994;* A. H. Smith, Oregon, *24133, 24160, 24477.*

Observations: The microscopic characters of the type are as given in the above description. This species is very similar to *N. elongatum* but differs in its much longer pleurocystidia and habitat.

9. NAEMATOLOMA ELONGATUM (Pers. ex Fr.) Konrad, Bull. Bimen. Soc. linnéenne Lyon, 8 année, n. 18, p. 135. 1929. FIGS. 7, 8.

Agaricus udus var. *elongatus* Pers. ex Fries, Syst. Myc. **1**: 292. 1821.

Hypholoma elongatum Ricken, Die Blätterpilze, p. 250. 1912.

Naematoloma udum var. *elongatum*, Karsten, Bidr. Finl. Nat. Folk **32**: 497. 1879.

Agaricus elongatipes Peck, Ann. Rep. N. Y. State Mus. **29**: 40. 1878.

Hypholoma elongatipes Smith, Mycologia **33**: 5. 1941. (Not *H. elongatipes* Parker, Mycologia **25**: 196. 1933.)

Naucoria obtussissima Kauffman apud Smith, Pap. Mich. Acad. Sci. **17**: 188. 1933.

Pileus 6–20 mm. broad, convex to obtuse, becoming broadly convex to nearly plane in age, surface moist, glabrous or with only a faint fringe of fibrils along the margin, hygrophanous, color when moist pale to deep yellow ("colonial-buff," "cream-buff," "chamois" or deep "olive-buff," becoming "mustard-yellow," "honey-yellow" or paler and fading to "massicot-yellow"), paler yellow when faded and in age often somewhat olivaceous; flesh thin, soft, pale yellow, odor and taste not distinctive; lamellae broad, adnate, subdistant, whitish to pallid yellowish at first, gradually becoming sordid brown ("clay-color" at times, but usually nearer "wood-brown"), edges at times whitish fimbriate; stipe 4–10 cm. long, 1.5–2.5 mm. thick, equal, tubular, strict, often slightly flexuous, sometimes undulated, pallid, becoming yellowish, silky above, with fibrillose flecks downward from the remains of the thin veil, becoming tawny from the base up in age.

Spores (8–)9–11(–12) × 5–6(–7) μ, ellipsoid, apices obscurely truncate from a small hyaline pore, pale reddish brown under the microscope, smooth, basidia 28–32 × 8–9 μ, four-spored, yellow in KOH; pleurocystidia scattered, ventricose-mucronate and with a highly refractive amorphous central body or narrowly fusoid-ventricose and homogeneous, the former 26–34 × 8–12 μ, the latter 30–36 × 5–9 μ; cheilocystidia abundant, 24–32 × 6–9 μ, subcylindric to narrowly fusoid-ventricose, apices obtuse, content homogeneous; gill trama parallel to subparallel; pileus trama with a very poorly organized pellicle of narrow (2.5–4 μ) hyphae bearing clamp connections, beneath it a well differentiated hypoderm, the cells up to 30 μ in diam., remainder of flesh interwoven, the hyphae 6–12 μ in diam.

Habit, habitat and distribution: Gregarious to scattered in sphagnum bogs, occasionally on *Polytrichum*. It fruits during late summer and fall, and is often abundant during dry summers. It is known from New York, Ontario, Michigan, West Virginia, Tennessee and Washington.

Material studied: L. R. Hesler, Tennessee, *14250, 17198;* H. D. House, New York, 1 collection; C. H. Kauffman, Michigan, 5 collections including type of *Naucoria obtusissima;* C. H. Peck, type of *Psilocybe elongatipes;* A. H. Smith, New York, Ontario and Michigan, *33–778, 33–821, 33–989, 33–990, 335, 372, 922, 4612, 4779, 6123, 11031, 12062, 14800, 14942, 26796, 31898, 31899, 32020,* one unnumbered collection from Lake Ozette, Wash., with cheilocystidia not similar to those in type of *elongatipes;* M. B. Walters, West Virginia, *131.*

Observations: The description of the microscopic characters is taken from American collections which are typified by Peck's type of *P. elongatipes.* There may be slight differences between the cystidia of the American and European forms of the species, but I have insufficient information on the European form to maintain any taxa below the rank of species. The distinguishing features of the species are the yellow cap which becomes paler yellow when faded and the dull-cinnamon-brown spore deposit. *N. elongatum* can be readily recognized at sight in our sphagnum bogs.

10. **Naematoloma squalidellum** (Pk.) comb. nov. FIGS. 12, 13, 14, 30, 31, 32, 57, 58.

Agaricus squalidellus Peck, Ann. Rep. N. Y. State Mus. **29**: 40. 1878.

Hypholoma squalidellum Saccardo, Syll. Fung. **5**: 1041. 1887.

Psathyrella petasiformis Murrill, Mycologia **14**: 276. 1922.

Naematoloma petasiforme Smith, Mycologia **40**: 694. 1948.

Pileus 1–3(–4) cm. broad, conic to convex, becoming campanulate, expanded and with an obtuse umbo or plane to broadly convex in age, the margin frequently recurved in umbonate forms, surface glabrous and moist, either opaque or the margin faintly striatulate, margin occasionally decorated with scattered fibrils from the remains of the rudimentary veil, color variable, bright

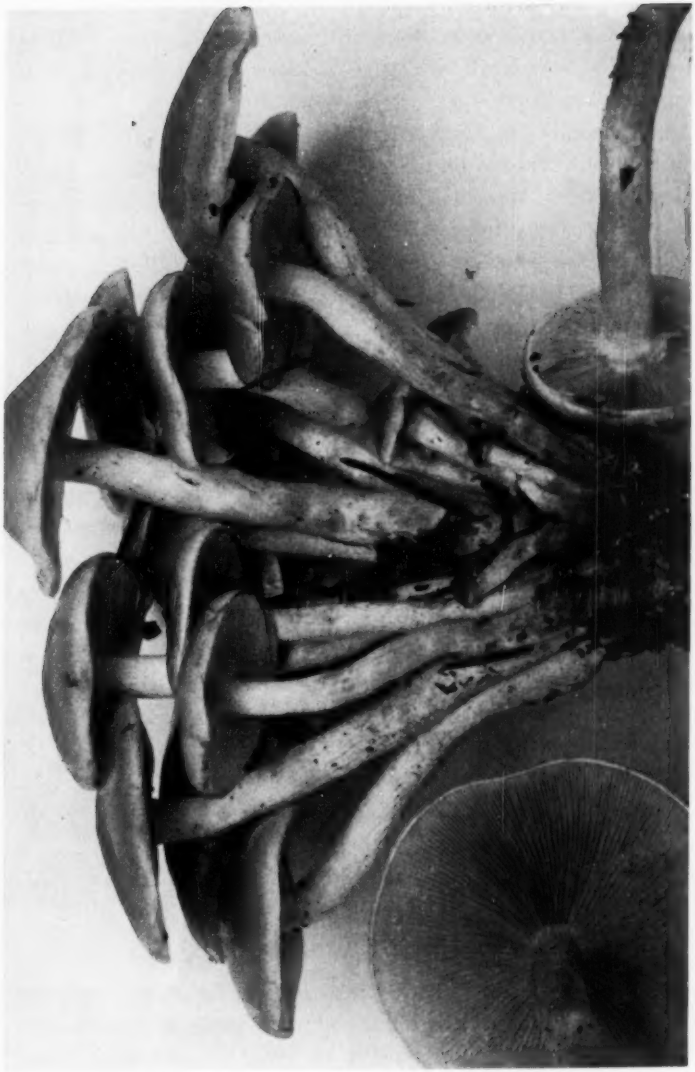


FIG. 60. *Naematoloma capnoides* (Fr.) Karsten × 1.

or sordid rusty brown when moist, subhygrophanous and fading to yellowish buff ("zinc-orange," "cinnamon-rufus," "Saccardo's-umber," "clay-color" or near "cinnamon-brown' at first and fading to "ochraceous-buff," "honey-yellow," or "deep colonial-buff"); flesh thin but firm, somewhat cartilaginous, yellowish in age, pallid when young, odor and taste not distinctive; lamellae close, narrow or becoming broad only in extreme age, adnate, sometimes developing a slight tooth, whitish at first or pale olivaceous-gray, sometimes "pale greenish yellow," at other times developing a strong olive tinge before becoming purplish brown, edges even; stipe variable in length depending on the habitat, when on naked peat 3–5 cm. long, when in moss 6–10 cm. long, 1.5–3 mm. thick, equal, usually flexuous when growing in the open, very brittle and cartilaginous, covered at first with scattered patches of appressed fibrils which are the remains of a rudimentary partial veil, apex pruinose, pallid-brownish toward the base when young, in age becoming rusty-brown and finally "bister" (sordid blackish brown), paler and olivaceous to pale yellowish above.

Spores (8–)9–11(–12) × (4–)5–6 μ, smooth, ellipsoid, with an apical hyaline pore, bright-purplish under the microscope when fresh, sordid yellowish brown or pale bister when revived in KOH; basidia four-spored, 24–30 × 7–9 μ; pleurocystidia numerous, 28–40 × (8–)9–12 μ, ventricose and mucronate, with a highly refractive amorphous content when revived in KOH, scarcely projecting beyond the basidia; cheilocystidia abundant, hyaline, fusoid-ventricose to clavate, 28–35 × 6–9 μ; pileus trama with a poorly formed subgelatinous pellicle and a differentiated hypoderm of enlarged cells up to 30 μ in diam., the tramal body of hyphae 7–12(–15) μ in diam., clamp connections present.

Habit, habitat and distribution: Cespitose to gregarious or scattered, usually on humus or debris in bogs or on peaty soil or rich humus in low woods, it is sometimes found in abundance on the debris left along streams from the over-flow during high water. It fruits during the late summer and fall and occurs in the Cape Flattery region of the Olympic Peninsula of Washington as well as in the northeastern part of North America. I have found it common during dry seasons.

Material studied: Peck's type at Albany, N. Y.; A. H. Smith, New York, Ontario, and Washington, *215, 262, 271, 286, 287, 2504, 3025, 4070, 4119, 4501, 14801, 29762.*

Observations: It seems more logical to refer *P. petasiformis* Murr. to this species than to *N. dispersum* because of the somewhat larger spores of *N. squalidellum*. In Murrill's type they measure 8–10 × 5–6 μ. The other microscopic characters as ascertained from the type support this synonymy.

11. NAEMATOLOMA POLYTRICHI (Fries) Konrad, Bull. Bi-men. Soc. linnéenne Lyon, 8 année, n. 18, p. 135. 1929. FIGS. 33, 34.

Agaricus udus Polytrichi Fries, Syst. Myc. **1**: 292. 1821.

Psilocybe uda var. *Polytrichi* Gillet, Les Hymén. p. 586. 1878.

Naematoloma udum var. *Polytrichi* Karsten, Bidr. Finl. Nat. Folk **32**: 497. 1879.

Hypholoma Polytrichi Ricken, Die Blätterpilze, p. 249. 1915.

Pileus 10–25 mm. broad, obtusely conic becoming campanulate and finally expanded, with or without a low umbo, glabrous except for scattered superficial fibrils along the margin at first, subviscid to moist, subhygrophanous, "clay-color," "tawny-olive" or "Isabella-color" at first (dingy pale tawny to olivaceous brown), fading to near "chamois" (pale yellow), opaque when moist or only the extreme margin translucent-striate; flesh yellowish, cartilaginous, odor and taste not distinctive; lamellae close, narrow (2–3 mm.), bluntly adnate, "olive-ocher" to "olive-yellow" (greenish yellow) at first, becoming dark sordid purplish-brown; stipe 5–7 cm. long, 1.5–2.5 mm. thick, equal, rigid and very cartilaginous, smooth or twisted, glabrous or with faint patches of appressed fibrils below, pruinose above, tawny-brown toward the base and becoming sordid over the lower portion in age, apex near "olive-ocher" (pale greenish yellow).

Spores 7–9 × 3.5–4(–4.5) μ, ellipsoid, smooth, with an apical pore, purple-brown in water mounts fresh, pale bister revived in KOH; basidia four-spored, 18–22 × 5–6.5 μ; pleurocystidia abundant, 40–60 × 10–12(–15) μ, mucronate, with an amorphous content when revived in KOH; cheilocystidia 28–36 × 7–10 μ, fusoid-

ventricose, some subcylindric, hyaline, content not distinctive; pileus trama with a slightly differentiated hypoderm beneath a very thin subgelatinous pellicle, tramal body of compactly interwoven hyphae, clamp connections present.

Habit, habitat and distribution: Gregarious on moss in or near bogs or on wet ground, late summer and fall, rare. Kauffman had one collection from Lake Quinault, Washington, I have one from Michigan (Smith *33-943*) and Singer found it on Mt. Washington in New Hampshire.

Observations: The small spores relate this species to *N. dispersum* but it appears to be distinct in its habitat and darker spores as revived in KOH. As can be noted by comparing descriptions of the carpophores, *N. dispersum*, *N. Polytrichi* and *N. squalidellum* all have essentially the same macroscopic characters.

12. NAEMATOLOMA CAMPESTRE Smith, Mycologia **40**: 692. 1948. FIGS. 27, 28, 29.

Pileus (6–)8–15(–20) mm. broad, obtusely conic, expanding to broadly conic or subcampanulate, finally convex to nearly plane, surface glabrous or with a faint fringe of marginal fibrils when young, lubricous when moist, color "Verona-brown" to "warm sepia" or "auburn" to "pecan-brown" on disc, fading first to "pale pinkish-buff" or 'cinnamon-buff" (pale ferruginous), but in age darkening to pale tan, margin striate when moist; flesh pliant, thin, odor very faintly fragrant, taste mild to slightly bitterish; lamellae very broad, horizontally adnate with a decurrent tooth, readily seceding, subdistant (15–18 reach stipe), one tier of lamellulae, dull brown becoming near "snuff-brown" to very sordid-cinnamon-brown, edges even and not whitish; stipe short, 2–3 cm. long, 1–1.5 mm. thick, equal, cartilaginous-pliant, about "light pinkish-cinnamon" over all at first from thin remains of the light pinkish-cinnamon veil, soon darkening from base up to concolorous or darker than the cap, only somewhat glabrescent.

Spores 7.8–9.3(–10) × 4.6–5 × 5–6.7 μ, flattened slightly, angular-subspheric to angular-ovate or subelliptic with sides ± parallel and with faintly angled shoulders in face view, subelliptic in side view, pore apical but small, color pale-bister in KOH; basidia

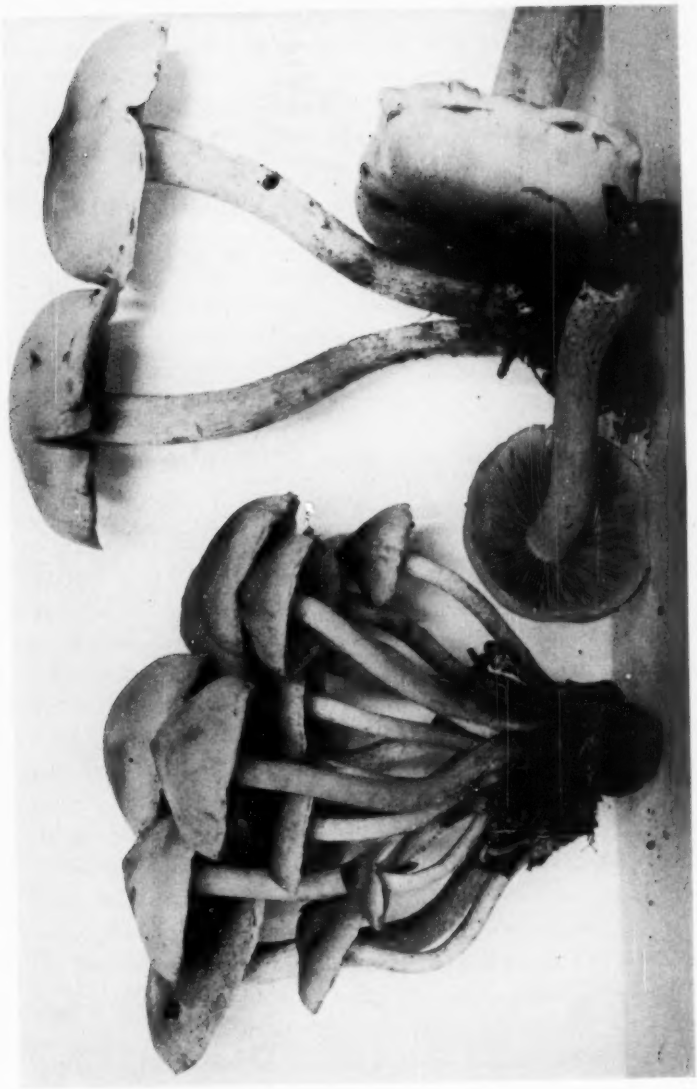


FIG. 61. *Naematoloma fasciculare* (Huds. ex Fr.) Karsten ×1 typical form.

four-spored, hyaline in KOH, 18–23 × 7–8 μ, subcylindric; paraphyses basidioid; pleurocystidia nearly imbedded in hymenium and originating from gill trama or subhymenium, ventricose-mucronate to fusoid-ventricose and with a highly refractice amorphous body as seen revived in KOH, 26–34 × 9–14 μ; cheilocystidia hyaline, thin-walled, homogeneous, 18–26 × 4–7 μ, subcylindric to subfusoid-ventricose with obtuse apices; gill trama of subparallel hyphae, pale to rather dark-bister as revived in KOH; pileus trama dark-bister to sordid-cocoa-color in KOH, homogeneous (no differentiated hypoderm or pellicle).

Habit, habitat and distribution: Gregarious on sod in pastures where *Agaricus campestris* is frequently found, definitely not on dung. Apparently rare and so far known only from Michigan.

Material studied: A. H. Smith, Michigan, *21426, 21426a.*

Observations: The aspect of the fruiting body is that of *Psilocybe,* as is also the structure of the pileus and the color reactions in KOH. The spores are slightly flattened as in many species of *Psilocybe,* but the pleurocystidia are definitely of the naematoloma-type. That the two genera intergrade here becomes more obvious when one considers certain collections made by Potter near Ithaca, Mich. which are described as a new species and have many cystidia with granular content as revived in KOH in addition to those that are typical of *Naematoloma.*

13. **Naematoloma Potteri** sp. nov. FIGS. 38, 39.

N. campestri similis sed sporae 9–11.5(–12) × 4.8–5.6 × 6–7 μ; in locis udis silvarum. Specimen typicum in Univ. of Mich. Herbarium conservatum: legit prope Ithaca, Mich., Potter n. *4423.*

Pileus 8–15 mm. broad, obtuse, expanding to broadly campanulate, convex, expanding to nearly plane, surface glabrous and moist, margin translucent-striate when wet, color dark rusty-brown, fading and hence hygrophanous, more or less alutaceous when dried; lamellae broad, broadly adnate to subdecurrent, subdistant, near Verona brown when dried; stipe short, 1–2 cm. long, ± 1 mm. thick, equal or narrowed downward, dull brown to about concolorous with pileus dried, apex pruinose, lower part at first with scattered fibrils from the rudimentary veil, soon becoming glabrous and naked.

Spores 9–11.5(–12) × 4.8–5.6 × 6–7 μ, flattened slightly, in face view oval-truncate to angular-ovate, truncate, in side view subelliptic, the suprahilar depression usually distinct, surrounded by a distinct gelatinous envelope, smooth, dark buckthorn-brown to pale bister in KOH, pore apical and distinct; basidia four-spored, rarely two-spored in some caps, 22–25 × 8.5–10 μ, hyaline in KOH or some yellow if collapsed; pleurocystidia scattered, 32–40 × 9–14 μ, clavate to mucronate, some almost ellipsoid, thin-walled, hyaline in KOH, content aggregated into a mass of highly refractive material or the refractive material more or less distributed as granules throughout the interior; gill trama subparallel, near ochraceous-tawny as revived in KOH or subhymenium deeper colored; pileus trama colored like the gill trama but progressively paler toward the pellicle, pellicle a very narrow layer of subgelatinous hyaline narrow hyphae, no hypoderm differentiated, clamp connections present.

Habit, habitat and distribution: Scattered on humus, Hart's woods, Ithaca, Michigan, Potter, *4423*.

Observations: The larger spores and habitat readily serve to distinguish this species from *N. campestre*, but the most important difference is the evenly dispersed granular content of many of the pleurocystidia as revived in KOH. A few rare species of *Psilocybe* are characterized by such cystidia, so that *N. Potteri* serves as a "connecting link" to them and to the genus *Psilocybe*.

Section Fascicularia

Habitat typically lignicolous, or, if appearing terrestrial, adjacent to old stumps, etc. Stipe furnished with a pseudorhiza in some species. Habit typically cespitose to subcespitose, rarely gregarious. Stipe (3–)5–10 mm. in diameter or thicker.

Key to Species

1. Stipe furnished with a well-developed pseudorhiza.....2
1. Stipe not as above.....3
2. Spores purple-brown in mass.....14. *N. radicosum*
2. Spores dull cinnamon-brown in mass.....15. *N. olympianum*
3. Pileus viscid; spores 5–6 × 2.5–3 μ.....16. *N. subochraceum*
3. Not as above.....4
4. Pileus typically reddish to brick-red; carpophore clustered on or near hardwood logs and stumps.....17. *N. sublateritium*

4. Pileus tawny, ochraceous, orange or greenish.....5
5. Lamellae whitish or grayish at first, sometimes becoming yellow.....6
5. Lamellae sulphur-yellow to green when young, becoming decidedly greenish.....8
6. Pilei 3–5(–7) cm. broad, tawny to yellowish.....18. *N. capnoides*
6. Pileus smaller (see *N. Polytrichi* also).....7
7. Cespitose and taste decidedly bitter.....19. *N. dispersum* var. *idahoense*
7. Gregarious and taste mild to slightly disagreeable.....19. *N. dispersum* var. *dispersum*
7. Pileus lubricous; lamellae soon bright-yellow.....19. *N. dispersum* var. *flavifolium*
8. Pileus 1–3 cm. broad, often conic; distribution southern (Caribbean area).....21. *N. subviride*
8. Pileus typically larger, distribution northern (see *N. dispersum* var. *flavifolium* also).....20. *N. fasciculare*

14. NAEMATOLOMA RADICOSUM (Lange) Konrad & Maublanc. Icon. Sel. Fung. **6**: 104. 1924–37. FIGS. 48, 49.

Hypholoma radicosum Lange, Dansk. Bot. Arkiv. **4**. no. 4, 39. 1923.

Pileus 2.5–4 cm. broad, convex becoming convex-expanded, not hygrophanous, slightly lubricous when moist but soon dry, more or less honey-colored or at times stained fuscous, disc usually darker, surface covered with a white bloom at first, vinaceous scales often present near the margin; flesh whitish or pallid, thick on the disc, rather abruptly thin toward the margin, odor acrid, taste bitter; lamellae adnate to somewhat adnexed but finally seceding, moderately close, narrowed outward and not broad, white at first, becoming fuscous to fuscous brown, edges whitish and eroded; stipe 6–10 cm. long, 5–8 mm. thick at apex, with a long flexuous pseudorhiza below the swelling, hollow, white above, rusty brown below, fibrillose scaly, scales rusty brown and often imbricate and more or less arranged in transverse zones, with an evanescent fibrillose apical zone left by the white delicate partial veil.

Spores purple-brown in mass, 5.5–7(–8) × 3–4 μ, ellipsoid to subovoid, smooth, dark dull brown (near "cinnamon-brown" revived in KOH) under the microscope, apical pore evident under oil-immersion; basidia four-spored, 22–24 × 5–6 μ, projecting slightly when sporulating; pleurocystidia abundant, 28–46 × 9–14 μ, fusoid-ventricose with acute apices or mucronate, the ventricose portion nearly always containing a highly refractive irregular

body; cheilocystidia typically more or less clavate to subventricose with obtuse apices and homogeneous hyaline content when revived, 18–26 × 5–8 μ; gill trama more or less regular, hyaline or nearly



FIG. 62. *Naematoloma fasciculare* (Huds. ex Fr.) Karsten × 1 large form.

so in KOH; pileus trama with a thin pellicle of slightly gelatinous narrow (2–3 μ) hyphae, beneath this a region of fulvous compactly arranged larger hyphae of about the same diameter as those of the

rest of the trama, remainder of trama hyaline or of dingy pallid hyphae (in KOH), clamp connections present.

Habit, habitat and distribution: Gregarious to somewhat clustered around or on decaying conifer wood, late spring and early summer. Three collections from Tennessee by L. R. Hesler are all I have seen.

Material studied: L. R. Hesler, Tennessee, *10381, 12543, 16393.*

Observations: This species and *N. olympianum* differ markedly in the color of the spore deposit and in the color of spores as revived in KOH. In the Friesian system they would be classed in different genera.

15. NAEMATOLOMA OLYMPIANUM Smith, Mycologia **38**: 502. 1946. FIGS. 50, 51.

Hypholoma olympianum Smith, Mycologia **36**: 248. 1944.

Pileus 2.5–4(–6) cm. broad, obtuse to convex and with an incurved margin at first, expanding to plane or retaining a slight obtuse umbo, surface at first canescent from a thin coating of whitish silky fibrils but soon glabrescent or fibrils more or less persistent toward the margin, moist, "cinnamon-buff" to "clay-color" on disc and paler yellow toward the margin (sordid honey-color to alutaceous); flesh hard and thick in the disc, abruptly thinner toward the margin (3 mm. at the stipe), pallid but soon lutescent where cut or broken, odor not distinctive, taste quickly and decidedly bitter; lamellae close, ± 33 reach the stipe, 3–4 tiers of lamellulae, narrow (3–4.5 mm.), bluntly adnate but seceding, "cream-buff" (very pale yellowish) young, "buckthorn-brown" in age (dark sordid yellowish brown) and often with dark rusty spots, edges even and pale yellowish; stipe 5–7 cm. long, 3–6 mm. thick, subfusoid to equal above a long tapered pseudorhiza, tubular to hollow, surface densely white-fibrillose from veil remnants, apex yellowish and pruinose, becoming yellowish where handled and finally dark sordid-brown, more or less glabrescent.

Spores dull cinnamon-brown in mass, when revived in KOH very pale dull brown, ellipsoid to ovoid, 6–7.5 × 4–4.5 μ, smooth, apical pore evident under oil-immersion; basidia four-spored, 18–22 × 5–6 μ, projecting somewhat when sporulating; pleuro-

cystidia abundant, 22–36 × 9–14 μ, ventricose and mucronate, with an irregular highly refractive mass in the enlarged portion; cheilocystidia abundant, 18–28 × 4–8 μ, subclavate to subventricose, the apices rounded; gill trama subregular, homogeneous; pileus trama with a very thin pellicle of narrow (1.5–2.5 μ), hyaline, subgelatinous (when revived in KOH) hyphae, beneath this a region of brownish compactly arranged larger hyphae, the remainder of hyphae of about the same size, loosely interwoven, and making up the trama, clamp connections present.

Habit, habitat and distribution: Gregarious to scattered around Douglas fir stumps, Olympic National Park, Washington.

Material studied: A. H. Smith, Washington, *18003* (type).

Observations: See *N. radicosum*.

16. NAEMATOLOMA SUBOCHRACEUM Smith, Mycologia **38**: 502. 1946. FIGS. 44, 45.

Hypholoma subochraceum Smith, Mycologia **36**: 250. 1944.

Pileus 2–4 cm. broad, convex with an inrolled margin and becoming broadly convex to plane, surface glabrous except for scattered fibrillose flecks along the margin from the broken veil, glutinous (slimy as in *Lactarius mucidus*) when wet, under a lens appearing somewhat appressed-fibrillose beneath the gluten, very pale ochraceous-tawny on the disc, "massicot-yellow" (pale clear yellow) near the margin, when young more or less "cinnamon-buff" (pallid alutaceous) over all; flesh thin, firm, equal, yellowish, unchanging, odor none, taste mild; lamellae close, ± 35 reach the stipe, 2 tiers of lamellulae, equal and narrow to moderately broad, adnate becoming depressed-adnate, pale yellow ("marguerite-yellow") young, becoming tinged sordid cinnamon-brown at maturity, edges even; stipe 5–9 cm. long, 5–7 mm. thick at apex, equal or slightly enlarged downward, tubular to hollow, surface over lower portion pale yellowish white from a thin coating of white fibrils which extends up to the evanescent zone left by the broken veil, yellowish beneath the fibrils (concolorous with the gills), apex yellow and silky, soon becoming sordid rusty brown from the base upward and glabrescent.

Spores dull snuff-brown in mass, very pale brown under the microscope, 5–6 × 2.5–3 μ, smooth, ellipsoid to narrowly ellipsoid,

apical pore visible under oil-immersion; basidia four-spored, 16–18 × 4–5 μ, projecting only slightly when sporulating, yellowish as seen in sections in KOH; pleurocystidia very abundant, ventricose-mucronate, 32–46 × 10–14 μ, with a highly refractive irregular body or bodies in the enlarged portion; cheilocystidia similar to pleurocystidia and abundant; gill trama subregular and yellow to brownish when revived in KOH; pileus trama homogeneous beneath a thick (75–150 μ) gelatinous pellicle of narrow (2–4 μ) yellow hyphae, clamp connections present.

Habit, habitat and distribution: Cespitose to gregarious on conifer logs, after the fall rainy season begins in the Cascade and Olympic Mountains.

Material studied: A. H. Smith, Washington and Oregon, *17526* (type), *19684, 19733, 19811, 19812, 19940, 20149, 20189, 24346, 24636, 24737, 24969, 26974, 27296, 27727, 28333, 27868, 31220, 31573, 31681, 31766, 31832.*

Observations: This species has been frequently collected in the central Cascades between Mt. Hood and Mt. Jefferson. It is difficult to dry, and in this respect resembles *Flammula astragalina*. The viscid pileus and pale-ochraceous colors make it very distinct in the genus.

17. NAEMATOLOMA SUBLATERITIUM (Fr.) Karsten, Bidr. Finl. Nat. Folk **32**: 495. 1879. FIGS. 52, 53, 59.

Agaricus sublateritius Fries, Epicr. p. 221. 1838.

Agaricus lateritius Schaeff. ex Fries, Syst. Myc. **1**: 288. 1821. (Not *Agaricus lateritius* Batt. ex Fr. Syst. Myc. **1**: 265. 1821.)

Hypholoma lateritium Kummer, Führer in die Pilzk. p. 72. 1871.

Hypholoma sublateritium Quélet, Champ. Jura et Vosges p. 143. 1872.

Geophila sublateritia Quélet, Enchir. Fung. p. 113. 1886.

Dryophila sublateritia Quélet, Flor. Myc. Fr. p. 154. 1888.

Agaricus perplexus Peck, Ann. Rep. N. Y. State Cab. **23**: 99. 1872.

Hypholoma perplexum Saccardo, Syll. Fung. **5**: 1028. 1887.

Pileus 2–8(–10) cm. broad, obtuse when young, becoming broadly convex or plane, sometimes with a low obtuse umbo, at times the margin uplifted in age, margin inrolled and white cottony-tomentose at first, with a pallid to pale yellowish appendiculate zone from the broken veil, surface moist, at first covered



FIG. 63. *Naematoloma dispersum* (Fr.) Karsten var. *dispersum* × 1.

over all by a thin canescent appressed whitish-fibrillose coating and dotted here and there by scattered patches of yellowish fibrils from the broken veil, in age (or in some collections even when young) glabrous at least over the disc, color more or less brick-red at least over the disc, margin usually paler ("cameo-brown" to "cacao-brown," on disc and "buff-pink" to whitish along the margin, grad-

ually fading to "orange-cinnamon" or "cinnamon" (cinnamon-color), sometimes yellowish where bruised and at times entirely yellow where covered by leaves; flesh thick, firm, pallid brownish, sometimes staining yellow where bruised, thick, odor none or slight, taste mild to bitterish; lamellae close but not crowded, 48–55 reach the stipe, 3–5 tiers of lamellulae, bluntly adnate and readily seceding, broadest (6–7 mm.) at attachment, equal to the abruptly narrowed outer end, white to pallid whitish, in some collections yellowish, in some olivaceous, becoming clouded gray and finally dark-purplish from the spores, edges even; stipe 5–9 cm. long, 5–10(–15) mm. thick, equal, solid, dull brown in age, pallid watery gray when young, cortex white at first, surface white over all and appressed-fibrillose below the fibrillose annular zone left by the broken submembranous veil, at times almost fibrillose-scaly below, soon staining yellowish and finally rusty-brown from the base upward, apex silky to pruinose.

Spores "dark vinaceous-gray" or "deep slaty brown" (fuscous-purple) in deposits, pale purplish in water-mounts of fresh material, 6–7.5 × 3.5–4 μ, with an obscure apical pore; basidia four-spored, 17–20 × 5–7 μ; pleurocystidia scattered to abundant, more or less imbedded in the hymenium, fusoid-ventricose to mucronate, 24–36 × 10–15 μ, usually containing a highly refractice irregular amorphous mass; cheilocystidia 26–34 × 7–9 μ, fusoid-ventricose with obtuse to subcapitate apices; gill trama parallel, hyphae 4–8 μ in diam., pileus trama with a thin subgelatinous pellicle of hyphae 2.3–4 μ in diam., beneath this a hypoderm of colored cells compactly arranged and 5–12(–15) μ in diam., the remainder of floccose narrower hyphae.

Habit, habitat and distribution: Cespitose to gregarious on decaying hardwood logs, stumps, or buried roots, late summer and fall. This is one of the very common species in the Great Lakes Region, and hardwood areas generally in eastern North America. It is rare west of the Great Plains.

Material studied: R. P. Burke, Alabama, *2020, 2040,* BK, BL, and 1 unnumbered collection; J. O. Cottingham, Indiana, *48;* John Dearness, Ontario, E. & E. N. Amer. Fungi No. *3203;* F. O. Grover, Ohio, Fungi of Erie County, Ohio No. *90,* Fungi of Laraine County, Ohio No. *1394;* J. W. Groves, Ontario, *11129;*

H. T. Güssow, Quebec, *F-8782;* L. R. Hesler, Tennessee, *9703, 10913, 12378, 13042,* and 1 unnumbered collection; Paul R. Harding, Jr., Ohio, 1 collection; H. A. Imshaug, Michigan, *3825, 3908;* L. N. Johnson, Michigan, No. *1908,* C. H. Kauffman, N. Carolina, New York, Pennsylvania, and Michigan, 12 collections; Roy Latham, New York, *22170, 22590;* H. A. Kelley, Maryland, *233, 1950;* Victor Potter, Michigan, *6276, 6742;* A. H. W. Povah, Michigan, F. *p.-606,* Shiras *87;* A. H. Smith, Michigan and New York, *33–835, 33–956, 484, 560, 4970, 4971, 7611, 7669, 7685, 11113, 11126, 18774, 18831, 18914, 20540, 21145, 21527, 22302, 23421, 26447, 31934, 32016, 32036, 32064, 32065, 32066, 33189, 33420,* also 3 unnumbered collections; L. E. Wehmeyer, Nova Scotia, *514;* John Williams, New Jersey, 1 collection.

Observations: No taxa below the rank of species are recognized here because the variability of the plant is so great and because of the presence of semi-sterile forms. One can find collections which "fit" var. *perplexum* and var. *squamosum,* but if these are recognized a long list of others would be necessitated with the end result that all possible combinations of the characters used would be named in one category or another. It is true that by going to the same stump each year one can collect the same variation, but it must be remembered that the same mycelium is very likely producing all the carpophores. The same is true of the semi-sterile forms even when the degree of sterility is so high that one can find only one or two spores on sections of gills from completely expanded pilei.

18. NAEMATOLOMA CAPNOIDES (Fr.) Karsten, Bidr. Finl. Nt. Folk **32**: 495. 1879. FIGS. 42, 43, 60.

Agaricus capnoides Fries, Syst. Myc. **1**: 289. 1821.

Hypholoma capnoides Kummer, Führer in die Pilzk. p. 72. 1871.

Geophila capnoides Quélet, Enchir. Fung. p. 113. 1886.

Dryophila capnoides Quélet, Flor. Myc. Fr. p. 154. 1888.

Dryophila fascicularis var. *capnoides* Quélet, Flor. Myc. Fr. p. 478. 1888.

Pileus (2–)3–5(–7) cm. broad, obtuse to convex and with an inrolled margin at first, expanding to broadly convex to plane, at

times with an obtuse umbo, surface moist but not truly hygrophanous, hoary-silky at first or with a few thin patches of buff fibrils and soon glabrescent, margin at first appendiculate from patches of fibrils, color "cinnamon" to "ochraceous-tawny" or "orange-rufus" (more or less bright fulvous to yellowish brown on the disc), the margin usually pale yellowish, when mature often "ochraceous-buff" (buff-yellow) on the disc and pale yellow ("light buff") on the margin; flesh moderately thick (3–5 mm.) and firm, tapering gradually to the margin, white to pallid, odor and taste not distinctive; lamellae close, 38–42 reach the stipe, 3 tiers of lamellulae, moderately broad to narrow (2.5–3.5 mm.), rounded-adnate, readily seceding, white to grayish white when young, soon clouded grayish-purple-brown, edges even; stipe 5–7(–10) cm. long, (3–)4–8(–10) mm. thick, equal or slightly enlarged at the base, base somewhat strigose, terete or compressed, tubular or becoming hollow in age, becoming darker tan or rusty brown in age from the base upward, sparsely fibrillose up to the faint annular zone left by the broken veil, apex somewhat pruinose to subglabrous.

Spores when fresh dull purple-brown in water mounts of fresh material, dull yellowish brown when revived in KOH, ellipsoid, smooth, 6–7 × 4–4.5 μ, with a small apical pore giving the spore an obscurely truncate appearance; basidia four-spored, 18–20 × 5–6 μ; pleurocystidia abundant to scattered, usually obovate-mucronate but varying to subclavate, 22–30 × 7–10 μ, with a highly refractive content and, hence, readily discernible when revived in KOH, inconspicuous in water mounts of fresh material; cheilocystidia similar to pleurocystidia (these are rare) or fusoid-ventricose with obtuse apices, hyaline, 16–24 × 6–9 μ; gill trama subregular, homogeneous, subhymenium very narrow; pileus trama homogeneous beneath a cuticle of enlarged (10–14 μ in diam.) hyphae with a rusty-brown incrusting pigment over the walls, appearing cellular in sections, a very thin pellicle of narrow (3–4 μ) hyphae present at first but this often not evident in mature caps, clamp connections present.

Habit, habitat and distribution: Typically cespitose to densely gregarious on the wood of conifers in the western mountains and along the Pacific Coast. It is common in this region during warm wet fall seasons. In the eastern part of North America it is most

abundant northward. From this region I have seen material from Michigan, Ontario, New York and Tennessee.

Material studied: Wm. B. Cooke, Idaho, *22121;* J. B. Flett, Washington, 3 collections; F. L. Drayton, Quebec, *F-7562;* J. M.



FIG. 64. *Naematoloma udum* (Pers. ex Fr.) Karsten × 1 typical form.

Grant, Langley, Washington (distributed as *Psilocybe conissans* PK); Wm. B. Gruber, Oregon, *9–6, 20–2, P–93, 722;* L. R. Hesler, Tennessee, *9615;* C. H. Kauffman, New York, Michigan, Idaho, Washington, Oregon, 13 collections; Elias Nelson, Washington, *22, 29;* Salisbury, Cowichan Lake, British Columbia, 1 collection; Frank P. Sipe, Oregon, *764, 921, 948;* A. H. Smith,

New York, Michigan, Ontario, Washington, Oregon and California, *772, 3100, 3832, 4703, 8140, 9031, 11112, 13829, 16274, 16486, 16935, 17942, 18065, 18168, 18169, 19139, 19498, 19499, 20220, 23866, 24322, 24330, 24542, 27132, 27187, 27913, 31478, 31723, 33977, 34071.*

Observations: At times this fungus fruits in tremendous clusters of relatively small carpophores and other collections may be found with relatively few, larger fruiting bodies. During unfavorable seasons or after a heavy fruiting period solitary specimens may occur and if small may closely resemble *N. dispersum*. A critical study of the type of *Hypholoma tsugaecola* has revealed that it is merely a group of old, robust carpophores of *Kuehneromyces mutabilis*. The characteristic naematolomoid pleurocystidia are lacking in the type and it agrees with *K. mutabilis* in all other respects. However, in the field one can chance upon collections of each species which have a sufficiently similar appearance to cause confusion.

19. NAEMATOLOMA DISPERSUM (Fr.) Karsten, Bidr. Finl. Nat. Folk **32**: 496. 1879.

Var. **dispersum**. FIGS. 40, 41, 63.

Agaricus dispersus Fries, Epicr. Syst. Myc. p. 222. 1838.

Hypholoma dispersum Quélet, Champ. Jura et Vosges, p. 144. 1872.

Geophila dispersa Quélet, Enchir. Fung. p. 113. 1886.

Dryophila dispersa Quélet, Fl. Myc. Fr. p. 153. 1888.

Agaricus fascicularis var. *marginatus* Fries, Syst. Myc. **1**: 289. 1821.

Hypholoma marginatum Schroeter, in Cohn, Krypt. Fl. Schles. p. 571. 1889.

Psilocybe ochraeceps Kauffman, Pap. Mich. Acad. Sci. Arts and Letters **5**: 143. 1926.

Pileus 1–3.5(–4) cm. broad, conic to convex, broadly umbonate in age, surface glabrous on the disc and faintly silky near the appendiculate margin, lubricous when moist, not striate, color variable, orange-tawny to tawny at first, becoming yellowish to sordid olivaceous toward the margin, fading slowly to sordid yellow or buff (only subhygrophanous) ("ochraceous-orange"

to "ochraceous-tawny," becoming "honey-yellow" to "Isabella color" near margin, fading slowly to sordid "ochraceous-buff" or "warm-buff"); flesh thin, odor none, taste mild to slightly unpleasant; lamellae broad, adnate, close, white to whitish at first, becoming sordid-olive and finally purplish brown, edges whitish; stipe 6–10 cm. long, 2–5 mm. thick, equal above a slightly enlarged more or less strigose base, brittle to tough and pliant (in large carpophores), covered by a dense silky-fibrillose layer to near the pruinose apex, at times with faint fibrillose patches or subannular fibrillose zones over the lower portion, lower part dark reddish-brown to bister beneath the fibrils, pale above and yellowish.

Spores 7–9(–10.5) × 4–5 μ, ellipsoid, smooth, with an apical pore, dull tawny brown when revived in KOH; basidia four-spored, 18–24 × 6–7 μ; pleurocystidia abundant, 32–48(–60) × 8–12(–15) μ, mucronate, the enlarged portion with a highly refractive content; cheilocystidia abundant, fusoid-ventricose to subcylindric, 18–22(–34) × 6–9 μ, hyaline, content homogeneous, apex rounded; gill trama parallel to subparallel, yellowish to orange when revived in KOH, subhymenium indistinct; pileus trama with a very thin subgelatinous pellicle of ± hyaline hyphae 2.5–4 μ in diam., beneath it an orange-brown (in KOH) hypoderm of enlarged (8–12 μ) hyphae, the remainder floccose and interwoven, paler than the hypoderm or nearly concolorous with it, and at times not sharply separated from it.

Habit, habitat and distribution: Single to gregarious on debris under conifers or around and on very rotten conifer wood, often abundant on chipdirt, sawdust, etc. It fruits during the late summer and fall and is to be regarded as a common species in the Pacific Northwest. I have seen the typical variety east of the Great Plains only in northern Michigan.

Material studied: J. B. Flett, Washington, 2 collections; C. H. Kauffman, 4 collections as *Psilocybe ochraeceps*, 1 unidentified; Frank P. Sipe, Oregon, *247, 539, 785, 947;* H. A. Imshaug, Washington, *1732, 2142;* A. H. Smith, Washington, Oregon and California, *2762, 3077, 3205, 3336, 3344, 3345* (sterile form); *3656, 7993, 8149, 8263, 8511, 8787, 9020, 9421, 14478, 14618, 14674, 14715, 19774, 19999* (very bitter), *20167, 24006, 24017, 24263,*

25058, 27737, 28024, 29863, 30027, 31024; Tequamenom State Park, Mich. 1949.

Observations: This species is intermediate between the sections *Fascicularia* and *Tenacia* in that the habitat places it in the former and the stature of the fruiting body in the latter. The smaller spores aid in distinguishing it from most species of section *Tenacia* such as *N. squalidellum,* with a habitat on debris. Although one can recognize the larger species of *Naematoloma* in the field without reference to microscopic characters, it is impossible to clearly distinguish all the members of the section *Tenacia* and *N. dispersum* on the same basis. Spore size is a character of major importance here among the slender species. Sm-*19999* on a conifer log, East Fork of Salmon River, Mt. Hood, Oregon, is a collection of carpophores with a very bitter taste.

N. DISPERSUM var. **idahoense** comb. nov.

Hypholoma dispersum var. *idahoense* Smith, Mycologia **36**: 247. 1944.

Pileus 1–2.5 cm. broad, obtusely conic with an incurved margin, becoming campanulate to broadly convex with a small conic umbo, surface moist and glabrous except for the appendiculate margin, veil remnants adhering to margin as a thin submembranous band or the band broken up into patches, subhygrophanous, dull tawny to cinnamon-brown on the disc, paler toward the margin, fading around the disc first to sordid ochraceous; flesh thin, pallid, odor not distinctive, taste distinctly bitter and leaving a persistent after taste; lamellae close, ascending adnate, narrow to moderately broad, white or whitish, becoming sordid grayish brown, edges white-floccose; stipe 6–8 cm. long, 1–2 mm. thick, equal, cartilaginous, sordid brown to bister below, gradually darkening upward, at first covered by a conspicuous coating of white fibrils causing it to appear white or silvery, apex whitish beneath the fibrils, lower down also whitish beneath the fibrils but eventually brownish, base conspicuously strigose with white to tawny hairs or mycelium.

Spores 7–8.4 × 3.5–4 μ, ellipsoid, apex truncate, dull-tawny in KOH; basidia 22–26 × 5–6 μ, four-spored; pleurocystidia abundant, mucronate, 26–34 × 8–10 μ, with a highly refractive irregular

amorphous mass or body in the central portion; cheilocystidia cylindric to subventricose, 30–36 × 4–6 μ, apices rounded, hyaline content homogeneous (in KOH); gill trama parallel, hyaline or nearly so; pileus trama with a thin subgelatinous pellicle of hyaline ± radially arranged hyphae 3–5 μ in diam., clamp connections



FIG. 65. *Naematoloma udum* (Pers. ex Fr.) Karsten × 1 short-stiped form.

present, beneath it a hypoderm of radially arranged hyphae 8–12 μ in diam. which are dark yellowish in KOH, the remainder of the tissue paler and not as compactly arranged.

Habit, habitat and distribution: Cespitose to subcespitose on conifer logs, in the mountains of central Idaho. Gruber *P–81* (type).

Observations: The strong persistently bitter taste and habit are the two important field characters. It is apparently quite wide-

spread in the area, and intergrades with var. *dispersum* west of the Cascades.

N. DISPERSUM var. **flavifolium** var. nov.

Var. *disperso* similis sed pileus lubricus, lamellae sulphureae et sapor mitis. Specimen typicum in Herb. Univ. of Mich. conservatum: Legit prope Lake Timagami, Ontario, Canada; A. H. Smith no. *4529*.

Pileus 1–3(–4) cm. broad, obtusely conic when young, becoming campanulate to broadly convex, at times plane or with a recurved margin, surface glabrous or with obscure patches of veil remnants adhering along the margin, subviscid from a very thin gelatinous pellicle, rusty brown to dull-cinnamon when moist ("ferruginous" to "Sayal-brown" or "cinnamon"), hygrophanous and fading to yellow ("naphthaline-yellow" near margin); flesh whitish or becoming yellowish, odor none, taste mild; lamellae close, narrow but in age moderately broad, bluntly adnate, sometimes seceding, whitish at very first but soon bright sulfur-yellow, gradually becoming clouded from the spores, edges white-fimbriate; stipe 3–8 cm. long, (1.5)–2–4 mm. thick, equal or base slightly enlarged by adhering mycelium and debris, tubular, very brittle-cartilaginous, pale yellow and slightly pruinose above, sordid-brownish toward the base, appressed silky-fibrillose, veil fibrillose and very thin.

Spores 7–8(–9) × 4–5 μ, purple-brown in water mounts when fresh, dull tawny revived in KOH, ellipsoid, smooth, truncate; basidia four-spored, bright yellow in KOH but fading to hyaline, 18–22 × 5.5–6 μ; pleurocystidia abundant, fusoid-ventricose to mucronate, 32–48 × 8–12 μ, with a highly refractive amorphous body; cheilocystidia of two types, similar to pleurocystidia or the common fusoid-ventricose type, the latter 18–26 × 4–8 μ, apices obtuse, varying in shape from ventricose to subcylindric, yellow at first (in KOH) but soon fading, content homogeneous; gill trama parallel; pileus trama with a very thin poorly organized pellicle which is subgelatinous in KOH, composed of hyphae 3–5 μ in diam. and furnished with clamp connections, beneath the pellicle is a hypoderm of bright yellow cells 8–20 μ in diam., the tissue beneath the hypoderm floccose, interwoven, and yellowish in KOH.

Habit, habitat and distribution: Gregarious to subcespitose on

conifer wood and debris, Michigan, Ontario and New York. It fruits during late summer and fall, and appears to be rare.

Material studied: A. H. Smith, New York, Ontario, and Michigan, *294, 4136, 4529* (type), *4877, 34041,* and 1 unnumbered collection.

Observations: This fungus appears to be intermediate between *N. dispersum* and *N. fasciculare,* but the mild taste, slightly larger spores, and lack of green in the gills indicates a closer similarity with the former. The bright-yellow colors of this variety do not appear to be associated with any degree of sterility. It can be distinguished from semi-sterile forms of var. *dispersum* by the lubricous pileus.

20. NAEMATOLOMA FASCICULARE (Huds. ex Fries) Karsten, Bidr. Finl. Nat. Folk **32**: 496. 1879. FIGS. 46, 47, 61, 62.

Agaricus fascicularis Huds. ex Fries, Syst. Myc. **1**: 288. 1821.

Pratella fascicularis S. F. Gray, Nat. Arr. Brit. Plants **1**: 627. 1821.

Hypholoma fascicularis Kummer, Führer in die Pilzk. p. 72. 1871.

Geophila fascicularis Quélet, Enchir. Fung. p. 113. 1886.

Dryophila fascicularis Quélet, Flor. Myc. Fr. p. 154. 1888.

Pileus (1–)3–6(–8) cm. broad, when young obtusely conic to campanulate, expanding to umbonate or becoming nearly plane, the margin incurved at first, surface glabrous or at times the cuticle breaking up to form spotlike scales, sometimes slightly silky toward the margin, somewhat lubricous when wet, margin at first hung with veil fragments, color "ochraceous-orange" on disc and "citron-yellow" (tinged green) along the margin, sometimes "amber-brown" on disc in age and the margin "straw-yellow"; flesh moderately thick (4 mm. near the stipe) tapering gradually to the margin, "citron-yellow" to "lemon-yellow," when cut changing to sordid brown, odor none, taste very bitter; lamellae crowded, 55–68 reach the stipe, several tiers of lamellulae, adnate, seceding, narrow (± 3 mm.), pale sulphur-yellow and becoming bright greenish yellow ("sulphur-yellow" to "pale greenish yellow" to "chrysolite-green" and finally "olive-citrine"), edges even; stipe 5–12 cm.

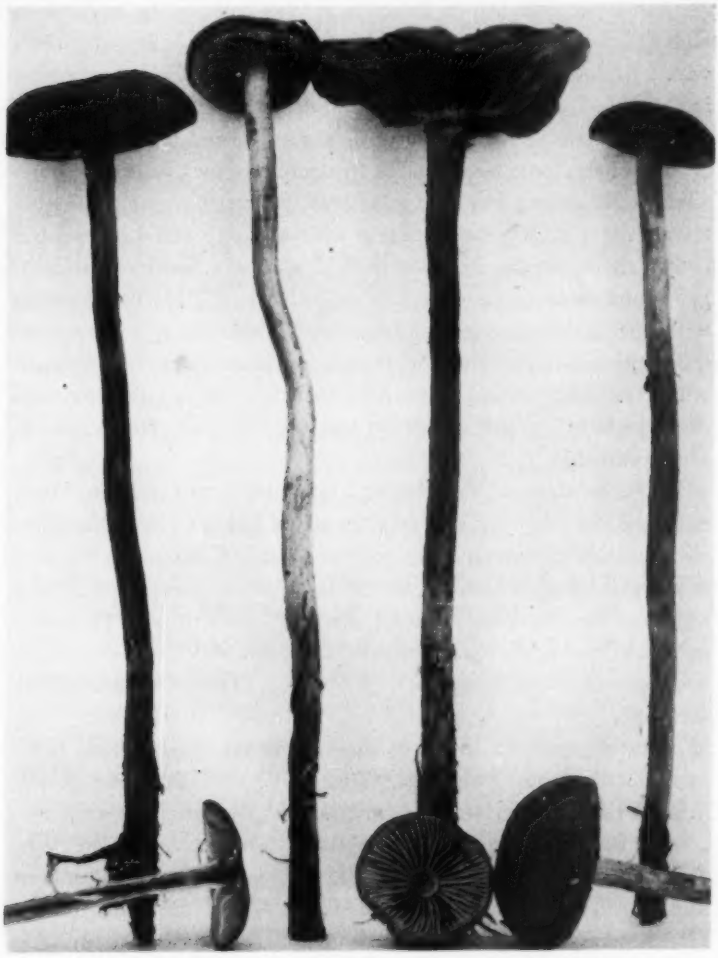


FIG. 66. *Naematoloma Myosotis* (Fr.) Smith × 1.

long, (3–)4–10 mm. thick, narrowed downward, hollow, fleshy at first but soon becoming tawny to ferruginous from the base upward, surface appressed-fibrillose or with an evanescent zone from the broken veil, apex pruinose to glabrous but unpolished, often wavy or undulating and somewhat contorted.

Spores purplish brown fresh, near clay-color when revived in KOH, 6.5–8 × 3.5–4 μ, ellipsoid to slightly ovoid, smooth, apex with a hyaline germ pore; basidia four-spored, hyaline to yellowish in KOH, 17–21 × 5–6 μ; pleurocystidia very abundant, 26–42 × 6–11 μ, ventricose with an abruptly narrowed and prolonged apex, or mucronate, some buried in the hymenium, some projecting somewhat, some arising from the gill trama, yellowish as well as highly refractive in KOH, some merely with a highly refractive central body; cheilocystidia 18–32 × 6–10 μ, obtusely fusoid-ventricose; gill trama more or less regular, yellowish in KOH; pileus trama with the cuticle scarcely differentiated; beneath it a somewhat differentiated hypoderm, the remainder interwoven and floccose, when revived in KOH often with an orange-brown zone beneath the hypoderm and yellow toward the subhymenium; clamp connections present.

Habit, habitat and distribution: Gregarious to cespitose, rarely scattered, on decaying logs and stumps of hardwoods and conifers alike but most commonly on conifer wood. Common throughout northern United States. It occurs both in the spring and fall and may also be found during mild winters. It is to be regarded as common in the Western United States but rare in the east. It has been collected a number of times in Tennessee and North Carolina.

Material studied: R. P. Burke, Alabama, "Hypholoma BB"; Univ. Calif. Herb. "California Fungi *464*"; Wm. B. Cooke, *20997;* J. B. Flett, Bremerton, Washington; J. W. Groves (communicated), British Columbia, North Arm Forest, Sept. 16, 1943; Wm. B. Gruber, Oregon, *10–5, 672, 703, 727;* L. R. Hesler, Tennessee and North Carolina, *10218, 11599, 13767, 17150;* Carl Hubbs, Great Smoky Mts. National Park, summer 1938; H. A. Imshaug, Washington, *1131, 1223, 1285, 1796;* C. H. Kauffman, Washington, Oregon and Montana, 8 collections; Rupert Leach, Oregon; E. Nelson, Washington; S. Pusateri, California, *20;* A. H. Smith, Tennessee, Washington and Oregon, *2481, 2498, 2564, 3083, 7539, 7920, 13079, 13098, 13264, 13572, 13707, 13708, 14708, 16401, 16414, 16614, 16889, 19061, 23870, 24082, 24550, 26676, 27685, 28291* (coll. *24296* represents a form with decurrent gills and mild taste); James R. Wier, Idaho, *16124*.

Observations: The combination of yellow to yellow-brown pileus and green gills at maturity distinguish this species from both *N. sublateritium* and *N. capnoides*. The very bitter taste is ordinarily a reliable character, but at Zigzag, Oregon, Gruber and Smith (Sm. *24296*) found a large cluster characterized by decurrent gills and a mild to only slightly bitter taste. The comments on variability of size of carpophore given for *N. capnoides* also apply here.

21. **Naematoloma subviride** (Berk. & Curt.) comb. nov. FIGS. 54, 55.

Agaricus subviridis Berkeley and Curtis, Jour. Linn. Soc. **10**: 292. 1868.

Psilocybe subviridis Saccardo, Syll. Fung. **5**: 1051. 1887.

Hypholoma papillatum Patouillard, Bull. Soc. Myc. Fr. **14**: 54. 1898.

Hypholoma flavovirens Murrill, Mycologia **10**: 68. 1918.

Pileus 10–30 mm. broad, obtuse-expanding to broadly convex or umbonate, dry, glabrous, in some faintly rugose, pale greenish yellow to somewhat olivaceous, at times darker on the disc; lamellae close to crowded, narrow, adnate, greenish-yellow becoming purplish brown at maturity; stipe 3–4 cm. long, 2–2.5 mm. thick, equal, smooth, glabrous, greenish yellow, more ochraceous below; veil slight, appendiculate, the remains evanescent.

Spores 7–8 × 3.5–4 μ, ellipsoid, smooth, truncate at apex from a small hyaline pore, dull yellowish brown under the microscope in KOH; basidia 18–20 × 6–6.5 μ, four-spored, greenish yellow in KOH; pleurocystidia abundant, 24–40 × 7–10 μ, usually with a small amorphous highly refractive substance in the broadest part, variously shaped, clavate, mucronate or fusoid-ventricose, often greenish yellow as revived in KOH; cheilocystidia scattered and similar to pleurocystidia; gill trama regular, subhymenium not distinctive; pileus trama metallic greenish yellow in KOH, with a poorly organized pellicle of non-gelatinous hyphae, beneath it a narrow hypoderm of radially arranged enlarged cells, the remainder floccose-filamentous with cells 10–15 μ diam.; clamp connections present.

Habit, habitat and distribution: Cespitose on logs, Cuba, Jamaica, and Mexico.

Observations: The microscopic data given above are taken from Murrill's type of *H. flavovirens* which was the best preserved of all the material studied. In Wright no. *71*, of *A. subviridis*, some cheilocystidia with homogenous content were found. All of these green-gilled species are so similar in their macroscopic characters as described that there appears to be no usable separation there.

Patouillard distinguished *H. papillatum* from *fasciculare* on the basis of the conic papilla of the pileus, but I am inclined to believe he merely had an extreme condition. The question may be raised as to whether or not *N. fasciculare* and *N. subviride* are distinct. I am inclined to consider them so, at least for the present, because of the difference in distribution and in secondary characters.

Excluded Species

1. *Hypholoma tsugaecola* Kauffman, Pap. Mich. Acad. Sci. **5**: 133. 1926.

The type of this species has been restudied in the light of the work of Singer and Smith (**1946**) on *Kuehneromyces*, and I am now convinced that Kauffman's type collection represents nothing more than large fruiting bodies of *K. mutabilis* in which the annulus has vanished. *Naematolomoid cystidida* were not found in repeated examinations of the type, and all the other microscopic characters check for *K. mutabilis*. During three seasons on Mt. Hoow I was unable to locate a *Naematoloma* that checked with Kauffman's species, but many old clusters of fruiting bodies of *K. mutabilis* were found which did. Kauffman's additional collections are mostly *N. capnoides*.

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CEPHALOSPORIUM FALCIFORME SP. NOV., A NEW ETIOLOGIC AGENT OF MADUROMYCOSIS

A. L. Carrión

In 1939 we published a report on the mycologic aspects of a case of maduromycosis produced by *Cephalosporium* in Puerto Rico (**1**). In an endeavor to identify the species causing infection in that instance, the fungus was subjected to careful study and its biologic characteristics were compared with those described for fifteen other *Cephalosporium* species which had been previously associated with human lesions of various clinical types by other authors. According to the observations made at that time, it was quite apparent that the organism found in the Puerto Rican patient represented a hitherto undescribed pathogen. However, certain similarities noted between our fungus and three of the compared Cephalosporiums, namely, *C.* sp. Negroni, *C. griseum* Gougerot,[1] and *C. keratoplasticum* Morikawa, led us to postpone the official definition of the species.

Since the publication of the original manuscript in 1939, our personal observations have been carefully reviewed and the fungus in question has been subjected to intensive study by several other investigators including J. E. MacKinnon,[2] of the Instituto Nacional de Higiene, Montevideo, Uruguay; F. P. de Almeida,[2] of the Facultade de Medicina, São Paulo, Brazil; and F. D. Weidman [2] and Albert Klingman,[2] of the University of Pennsylvania, United States of America. The observations of these workers would support our final conclusion that the Puerto Rican fungus is representative of a new species. Moreover, Almeida *et al.* were able to isolate a second specimen of this species from another case of maduromycosis occurring in Brazil (**2**).

[1] Gougerot has recently informed us that the original isolation of his species has been lost and this fungus has not been found either in the Centraalbureau voor Schimmelcultures at Baarn, Holland; or at the American Type Culture Collection at Washington, D. C.; or in several other authorized institutions from which it has been requested.

[2] Personal communication to the author.

In compliance with the International Rules of Botanical Nomenclature, we are, therefore, presenting the official definition of the species under the binomial *Cephalosporium falciforme,* the specific name being descriptive of the morphology of the conidia produced by the fungus in artificial cultures.

Cephalosporium falciforme may be readily distinguished from the three species above mentioned by its pathogenic habit, chromogenic properties, morphology of conidia and conidiophores, presence and morphology of chlamydospores, and production of nodular organs.

Cephalosporium falciforme sp. nov. Fungus maduromycosem gignens, generat in textis granula alba, ex filamentis et chlamydosporis formata. In "glucose agar" (4%) et in "Czapek-Dox agar," coloniam generat plus minusve circularem, post tertiam hebdomadam metientem 5 cm. ferme; in "glucose agar" cum tegumento superficiali filamentoso pallide violaceo et cum sulcis radiatis; vel etiam, in "Czapek-Dox," cum tegumento filamentoso replicato, in centro leucophaeo, et ad peripheriam uniforme pallido reddito; in "glucose agar" coloniae dorsum cum pigmento violaceo diffusibili, et in "Czapek-Dox" viridi colori similiter diffusibili. Examen microscopicum exhibet: (1) filamenta ramificata et in cratitii forma, quae metiuntur inter 1.3 et 3.6 μ amplitudine; (2) ramos fertiles longitudinis varias, aliquos multo magis longos quam microscopicae observationis campus; (3) conidia delapsa et agglutinata in sphericae massae formam supra rami fertilis cuspidem; conidia simplicia, elongata et ovalia in delapsu, denique incurvata et multicellularia, quae plerumque metiuntur inter 9 et 12 per 3 vel 4 μ, in longitudine attingenta iterum atque iterum circa 30 μ; (4) chlamydosporas abundantes post secundam vel tertiam hebdomadam, situ terminali, laterali vel interposito, majori parte, unicellulares et sphericas (inter 5.4 et 7.6 μ in diametro); alias ovales, globosas metientes, usque ad 13 μ longitudinis; alias multicellulares in unam vel duas planas divisas, in structurarum forma etiam 4 cellulas continentium; membrano cellulari crasso, fuligineo, lubrico; protoplasmate granulato, olivaceo et guttas pingues continente quae simulant aliquoties ascosporas; (5) in "glucose agar" post tertiam hebdomadam organa glomerularia organis dermatophytarum similia.

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THE LIPOPHILIC MYCOFLORA OF THE SKIN.

I. IN VITRO CULTURE OF PITYROSPORUM ORBICULARE N. SP.

MORRIS A. GORDON

(WITH 2 FIGURES)

In a recent publication (**3**), Benham presented an exhaustive review of the long series of attempts to culture from human skin the organism known as *Pityrosporum ovale* or "the bottle bacillus of Unna." In most of the apparently successful trials it was necessary to include some fatty material in the substrate in order to obtain good growth of the organism on subculture. Benham, in reporting her isolations in 1939 (**2**), stated that "The present case is the first instance in which a microorganism has been shown to require a fatty substance for continued growth."

The purpose of this paper is to report the isolation, from the epidermis of the shoulders, neck, chest, back, or upper arms of fifteen individuals, of a yeast-like organism which appears to be even more fastidious with respect to an oil medium than is *P. ovale,* and which differs from the latter distinctly and consistently in several morphological and physiological characteristics. Because of its affinities to the genus *Pityrosporum* and the spherical form of its cells, it is proposed that this lipophilic organism be named *Pityrosporum orbiculare.*

A search of the literature has revealed no previous report of culture of an organism which can be identified with this one, although it almost certainly has been observed and described on several occasions in its natural habitat. At least two other lipophilic yeast-like fungi, one of them apparently identical with *P. ovale,* have been isolated from glabrous skin on several occasions. Studies on the morphology of these, as well as on their comparative physiology, will be the subject of later papers.

HISTORICAL

In 1884 Bizzozero (**4**) described and named two yeast-like organisms which he had found consistently (together with a third type designated "large micrococci") in scrapings of human skin. The first, *Saccharomyces sphaericus,* consisted of spherical cells 2.5–5.8 μ in diameter, averaging 3.5–4.5 μ, occurring in clusters and possessing a thick, "double-contoured membrane" with a homogeneous interior. It multiplied by budding and formed no mycelium in the epidermal scales. The second, *Saccharomyces ovalis,* also lacked mycelium, reproduced by budding, measured 2.3–2.6 × 3.3–3.5 μ, and exhibited a "sharp and regular contour." He states that his choice of a generic name for these is provisional, pending a knowledge of the true nature of the cells and therefore of their systematic position. Previous mention of yeast cells in human epidermis had been made in 1873 by Rivolta (**23**), who noticed round, double-contoured budding cells in a case of psoriasis. He named them *Cryptococcus psoriasis.* Malassez, in 1874, described budding "spores" of various shapes, which occurred in abnormal skin conditions. He found spherical bodies, either double-contoured and 4–5 μ in diameter or without double contours and 2–2.5 μ in diameter, always present in scales from alopecia areata (**17**). Associated with pityriasis simplex were oval cells, the largest, including the bud, 4–5 × 2–2.5 μ, and the smallest only 2 μ long (**18**). These forms, which seem to correspond to Bizzozero's *S. sphaericus* and *S. ovalis,* came to be known as the "spores of Malassez." In 1904 Sabouraud (**24**), finding a polymorphic organism associated with pityriasis, gave it the name *Pityrosporum Malassezii.* It seems probable that Sabouraud's *P. Malassezii* also included both of Bizzozero's *Saccharomyces* species. Later, Castellani and Chalmers (**6**) made the combination *Pityrosporum ovale,* based on Bizzozero's *S. ovalis,* but including also his *S. sphaericus.*

Numerous attempts to culture the spores of Malassez have resulted in perhaps five acceptable claims to success [Castellani, 1925 (**5**); Acton and Panja, 1927 (**1**); Ota and Huang, 1933 (**20**); Benham, 1939 (**2**); and Emmons, 1940 (**9**)]. In all of these instances the organism obtained was reported difficult to culture, growing well only when some fatty substance was part of the sub-

strate. This characteristic, together with a more or less striking resemblance to the oval organism seen in scales, has been the main basis for identification of these cultures as *P. ovale*. In addition, Emmons presented evidence that his strains arose directly from the cells present in tissue. Van Hoorn (**12, 13**), in 1895, cultured two slow-growing yeasts, one of which he considered identical with *S. ovalis* and the other with *S. sphaericus* of Bizzozero. He credited the Dutch worker, Pekelharing, and also von Boeck with having cultured *S. sphaericus* previously. From the description of their isolates, it seems improbable that any was identical with *P. orbiculare*.

Benham and Emmons maintained their cultures on solid media to which were added ether extracts of lanolin, oleic acid, or other fatty materials. Ota and Huang found Petragnani's medium the best of those they tried. Acton and Panja employed glycerine-containing media, but Panja later (**22**) reported marked stimulation of growth by the addition of oils. A strain of *P. ovale* isolated by Acton in 1930 has been obtained from the collection of the London School of Hygiene and Tropical Medicine. This strain (FIG. 1a), here designated *F 18*, which fits the classic descriptions of the organism, can be carried successfully on wort agar or Sabouraud agar, but its growth is much more luxuriant when olive oil (or any of several other fatty substances) is added to the medium.

ISOLATION OF PITYROSPORUM ORBICULARE

Of the fifteen strains of *P. orbiculare* thus far obtained, thirteen grew originally from tinea versicolor scales planted on suitable media, the other two from apparently normal skin. However, despite the frequent association of the organism with tinea versicolor, its possible etiologic role in this disorder is questionable. A discussion of this relationship will be given elsewhere (**11**).

One strain was isolated in MacLeod's (**16**) peptone-glucose-oleic acid broth, but the medium was heavily contaminated with bacteria and subculture failed. All other isolates were obtained from scales placed on Sabouraud glucose agar (Difco) slants overlaid with two ml. of sterile olive oil. Isolation was accomplished best when antibiotics (twenty units of penicillin and forty units of strepto-

mycin per ml. of medium) were incorporated in the agar since, in their absence, the yeast usually became overgrown by bacteria. Tubes were incubated at 37° C., with solid media in a slanting position so that the agar surface was kept constantly in contact with the oil. Easily visible growth appeared in four to five days. As noted in the introduction, other lipophilic yeasts also were recovered, but on none of the oil media did there appear any fungus which was not markedly lipophilic.

CULTURAL CHARACTERISTICS

Under the proper conditions *P. orbiculare* may be maintained indefinitely in culture. Subcultures, as well as the original isolation, must be made to fresh agar, since drying of the medium is detrimental to the fungus. If the slant is kept covered with olive oil, transfers need be made no oftener than every three weeks. Transfers are made simply by streaking of the inoculum on the agar surface before the addition of the oil. The oldest strain now viable has survived twenty-three transfers over a period of fourteen months on Sabouraud agar plus oil, with or without antibiotics, incubated at 37° C.

First growth appears around the scales or from the culture inoculum as fine white granules, and the culture retains a yeasty-granular appearance until the entire slant has acquired, at the interface, a white to cream-colored layer (FIG. 1a). Daily tilting of the slant to redistribute the oil results in much more rapid growth.

The optimum temperature for incubation appears to be about 37° C., with 30° C. almost as good. At 25° C., there is no visible development at two weeks, but a very small amount of growth after thirty-five days.

P. orbiculare bears a marked resemblance microscopically to *S. sphaericus* of Bizzozero. Grown on Sabouraud agar with olive oil, it forms regularly spherical "double-contoured," single-budding cells, rarely with two or more buds. The buds are spherical to slightly elongate and are attached by a narrow isthmus, as contrasted with the characteristic broad base of *P. ovale* (FIG. 1d). The mature cells range from 2.1 to 4.8 μ in diameter, mostly 2.8 to 3.8 μ. When they are mounted in lacto-phenol cotton blue (FIG.

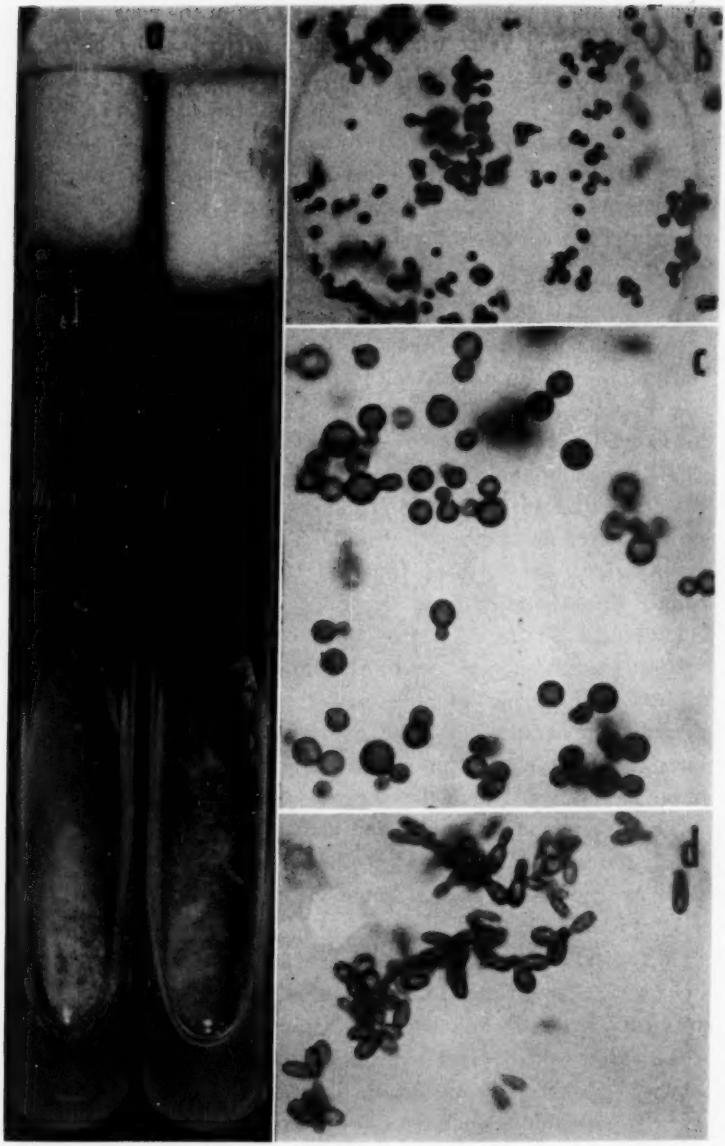


FIG. 1. a. *Pityrosporum orbiculare F 7* (left) and *P. ovale F 18*, on Sabouraud agar with olive oil. Age 3 weeks. Natural size. b. *P. orbiculare F 7*. Hotchkiss-McManus stain. × 645. c. *P. orbiculare F 7*. Hotchkiss-McManus stain. × 1470. d. *P. ovale F 18*. Hotchkiss-McManus stain. × 645.

2c) or in a permanent preparation (FIG. 2a) stained by the rapid methylene blue method (**10**), their interior presents an "empty" appearance, while the periphery stains an uneven dark blue, as though composed of a double wall whose interspace is only partially and irregularly filled. Prepared and stained by the Hotchkiss-McManus method (**14**) the cells show a deeply stained thick wall and a lighter, apparently homogeneous interior (FIG. 1b, c). Many of them, on close examination, seem to exhibit a number of small, more lightly-staining or unstained areas, distributed regularly on the cell wall. These are reminiscent of Bizzozero's (**4**) illustrations of *S. sphaericus* (Plate 13, figures 3a, b).

Scrapings of normal skin, stained by the Hotchkiss-McManus method (FIG. 2b), often show yeast cells, singly or in clusters, similar to those herein described.

Sabouraud agar without oils or other fatty substances will not support growth at any temperature tried (25°, 30°, 37° C.). Washed, vitamin-free agar overlaid with oil yields no growth. Corn meal agar (**7**) and wort agar with olive oil permit good growth, somewhat less than does Sabouraud agar, at 30° and 37° C. but not at 25° C. TABLE I shows, for several strains of *P. orbiculare*, relative volumes of growth observed on Sabouraud agar with single additions of various fatty substances. Solid fatty acids were dissolved in ether, which was layered on the slants and allowed to evaporate.

It will be seen that oleic acid, reported by Benham (**2**), Emmons (**9**), and Panja (**22**) to be among the best additives for *P. ovale*, is ineffective for *P. orbiculare*, as is linoleic, another unsaturated eighteen-carbon acid. Glucose (4%)-peptone (1%) broth overlaid with olive oil supports a fair amount of growth at the oil-water interface, when incubated at 37° C. Sabouraud agar plus mineral oil permits no growth. Other miscellaneous media found inadequate to support *P. orbiculare* are: MacLeod's glycerine agar (**16**), wort agar (Difco), Panja's modified Petroff agar (**21**), Sabouraud maltose agar (Difco), Czapek's agar, potato-dextrose agar, nutrient agar (Difco), corn meal agar, Moore's peptone broth (**19**), glucose-peptone broth plus one per cent saponin, and MacLeod's broth.

On corn meal agar plus olive oil, at 30° C., some strains of the fungus developed pseudo-hyphae, apparently representing elongated

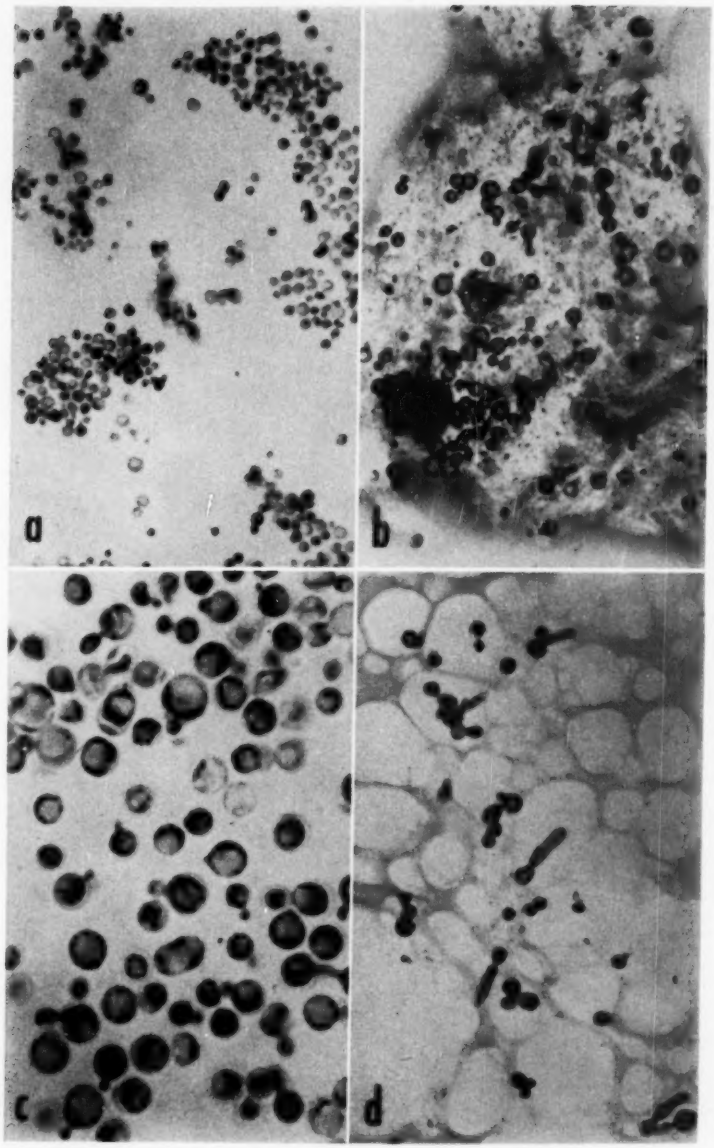


FIG. 2. a. *P. orbiculare F 10.* Stained by rapid methylene blue method. × 645. b. Scales from normal skin, containing spherical budding cells, Hotchkiss-McManus stain. × 645. c. *P. orbiculare F 17.* Mounted in lactophenol cotton blue. × 1470. d. *P. orbiculare F 17.* Grown on corn meal agar with olive oil at 30° C. Hotchkiss-McManus stain. × 645.

buds that had remained attached to the mother cells (FIG. 2d). The largest of these measured about 17 μ in length and was slightly smaller in diameter than the mother cell.

Attempts were made to formulate a solid medium upon which the organism would grow without the necessity of an additional oil layer. Olive oil (1 ml. and 2 ml. per 8 ml. of medium) and

TABLE I

GROWTH OF *Pityrosporum orbiculare* ON SABOURAUD AGAR + VARIOUS FATTY SUBSTANCES. INCUBATION AT 37° C. FOR THREE WEEKS

Additive	Strains					
	F 7	F 10	F 14	F 15	F 17	HL
Castor Oil	0	0	0	0	0	
Corn Oil	++++	++++	++++	++++	++++	++++
Cottonseed Oil	++++	++++	++++	++++	++++	++++
Linseed Oil	++++	++++	++++	++++	++++	++++
Olive Oil	++++	++++	++++	++++	++++	++++
Peanut Oil	++++	++++	++++	++++	++++	++++
Soybean Oil	++++	++++		+++	++++	+++
Lauric Acid	++	++		++++	++++	
Myristic Acid	++++	++++		++++	++++	
Palmitic Acid	++	++	++++	+++	+++	+++
Stearic Acid	++++	++++	++++	++++	+++	
Oleic Acid	0	0	0	0	0	0
Linoleic Acid	0	0	0	0	0	0
Glycerine	0	0			++	
Mineral Oil	0	0			0	

0	No growth
+	Barely perceptible growth
++	Fair
+++	Good
++++	Excellent

stearic acid (1 gm. and 0.5 gm.) were added to melted Sabouraud agar cooled to near-gelation, the mixture being emulsified thoroughly and then slanted. Although most of the oil or acid appeared at the surface upon solidification of the agar, none of four strains of the yeast made any growth in six weeks. In contrast, *P. ovale F 18* grew well on the oil media and to a slight extent on the stearic agars.

P. orbiculare, which should be classified with the Torulopsidoideae (**15**), is distinguished from all other yeasts in that subfamily, except *P. ovale*, by its peculiar growth requirements. Panja (**22**) stated that his three *Malassezia* species were stimulated mark-

edly by olive oil on solid media, but his organisms, since they produced hyphae, would be put in the subfamily Mycotoruloideae (**8**). Like *P. ovale* too, the new species has been isolated thus far only from epidermal scales, although most successful cultures of *P. ovale* have originated in dandruff while all strains of *P. orbiculare* have been obtained from glabrous skin. However, in this study, no attempt has yet been made to isolate *P. orbiculare* from the scalp, while, as mentioned above, several strains of what appear to be *P. ovale* have been cultured from areas other than the scalp.

The common characteristics of habitat and lipophilic nature appear to justify the inclusion of these two species in the same genus and their exclusion from other genera, although this requires emendment of the genus *Pityrosporum* as defined by Lodder (**15**) in her monograph on the Torulopsidoideae. Lodder characterizes *Pityrosporum* as: "Cells predominantly flask shaped, budding frequently on a broad base." It is proposed to redefine the genus to include anascosporogenous lipophilic yeast-like organisms of various shapes.

DIAGNOSIS

Pityrosporum Sabouraud 1904 *emend.*

Cells oval or spherical, occurring singly or in clusters of two or more, budding singly (rarely otherwise) on a broad or narrow base. Growth slow or lacking on Sabouraud agar; addition of fatty substances required for continued development on this medium; not supported by oil as sole nutrient. Growth luxuriant at 37° C., much less so or none at all at 25° C.

Pityrosporum ovale Castellani and Chalmers 1913, as described by Benham (**2**), is accepted as the nomenclatural type of the genus.

Pityrosporum orbiculare n. sp.

Cellulis sphaericis in cultu vulgo aggregatis, membrana duplici instructis, 2.1–4.8 μ diam., plerumque 2.8–3.8 μ, gemmulas unicellulare (raro 2–3) sphaericas vel ovale, ad basem angustata, gignentibus. In cultu in agar-agar Sabouraud vel agar-agar wort effecit colonias minutissimas nisi stratum olei olearis vel materiae oleaceae ad superficiem superimpositum. In cultu in mistura olei olearis vel acidi stearici crescit optime intra septem dierum spatium ad temperaturam 37° C., sed intra quatuordecim dierum spatium ad temperaturam 25° C. non crescit. Etiam non crescit in mistura acidi oleici,

nec olei metalici nec glycerini. In liquidis glucoso-peptoni-sicci, quod stratum olei olearis tegit colonias efformat ad interfaciem solum.

Hab. In squamis adest tinea versicolor is ac in cute sana hominis.

Cells spherical, usually in clusters on artificial media, double-contoured, 2.1–4.8 μ in diameter, mostly 2.8–3.8 μ, producing single (rarely 2 or 3) spherical to oval buds on a narrow base. On Sabouraud agar or wort agar very little growth unless olive oil or other fatty substance is layered on the surface; on Sabouraud agar and other media with olive oil or stearic acid, excellent growth at 37° C. after one week, no growth at 25° C. after two weeks; no growth with oleic acid or mineral oil and, in most strains, none with glycerine. On glucose-peptone broth overlaid with olive oil, growth occurs only at the interface.

Habitat: Isolated from the scales of tinea versicolor and from normal skin.

The type specimen of *P. orbiculare* is strain *F 7*, isolated October 20, 1949, from the scales of tinea versicolor lesions on an adult negro woman and maintained in this laboratory. Subcultures of the type have been deposited with the Centraalbureau voor Schimmelcultures, Delft, Netherlands, the American Type Culture Collection, Washington, D. C., and the London School of Hygiene and Tropical Medicine.

It is considered probable that *P. orbiculare* is the same organism as that labeled *S. sphaericus* by Bizzozero, especially inasmuch as examination of scales from normal individuals has repeatedly revealed such cells. However, lacking cultures of *S. sphaericus* it is impossible positively to connect Bizzozero's cells with the present cultures.

SUMMARY

A spherical yeast-like organism requiring the addition of fatty substances for isolation and continued growth on ordinary agar media has been cultured on several occasions from human epidermal scales and is described. It is distinct from *Pityrosporum ovale* morphologically and with respect to several physiological characteristics, although the latter species is also markedly lipophilic.

The genus *Pityrosporum* Sabouraud is emended to include the species made the basis of the present study and named *P. orbiculare*.

Evidence is presented to show that this organism differs from all hitherto described allied forms.

ACKNOWLEDGMENTS

Grateful acknowledgment is made to Professor Frederick A. Wolf, Dept. of Botany, Duke University, for the Latin translation of the diagnosis.

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U. S. PUBLIC HEALTH SERVICE,
ATLANTA, GEORGIA

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THE RELATION OF NUTRITION TO THE GROWTH AND MORPHOLOGY OF TRICHOPHYTON VIOLACEUM.

II. THE INFLUENCE OF NUTRITIONAL FACTORS ON THE MORPHOLOGY OF T. VIOLACEUM [1]

LUCILLE K. GEORG

(WITH 3 FIGURES)

In a previous paper (**14**), the vitamin and amino acid requirements of *T. violaceum* were discussed. Ten of eleven strains studied were found to be partially deficient for thiamine. One strain, although self-sufficient for vitamins, was completely deficient for the amino acid l-histidine. The presence of organic nitrogen greatly enhanced the growth of all strains, and of the amino acids studied, glutamic acid was found to be most effective.

It is the purpose of this paper to show the effect of various media, adequately supplied with these growth substances, on the gross and microscopic morphology of *T. violaceum*.

MATERIALS AND METHODS

Eleven strains of *T. violaceum*, ten which had a partial deficiency for thiamine and one which had a complete deficiency for l-histidine, were studied on different types of media.

Usual routine media: Sabouraud's dextrose agar (Difco), Sabouraud's maltose agar (Difco), and cornmeal-dextrose agar (**9**).

Special enriched media: Sabouraud's maltose "proof media" (prepared with the original ingredients used by Sabouraud, maltose de Chanut 40 g., peptone de Chaissaing 10 g., and 1000 ml. distilled water); Sabouraud's dextrose agar (Difco) enriched with 0.5 per cent trypticase (an enzyme-digested casein, Baltimore Biological

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Co.); heart infusion—tryptose agar (blood agar base, Difco); and whole unpolished rice grains.

Synthetic media: a "basal," vitamin-free medium prepared as follows: 50 g. dextrose and 0.1 g. $MgSO_4$ were placed in 1 liter of distilled water buffered to pH 7.0 with phosphate (M/15 Na_2HPO_4 and M/15 KH_2PO_4). To this was added either of two nitrogen sources, 0.2 per cent NH_4NO_3 or 0.2 per cent acid-digested casein (Baltimore Biological Co.). The media were solidified with 2 per cent pyridine-treated agar.

The basal media were also prepared with the addition of a supra-optimal dosage of thiamine calculated from results of titrations of this vitamin in NH_4NO_3 broth (**14**). 50 μg. thiamine was added to tubes containing 10 ml. of melted and partially cooled media.

All tubes were inoculated with fragments of the mycelial growth obtained from vitamin-free NH_3NO_4 agar slants.

RESULTS

Studies on usual routine media: A wide range of colonial variation was seen on Sabouraud's dextrose agar. The growth characteristics on this medium are presented in TABLE I. Growth on Sabouraud's maltose agar was similar in amount and character to that on the dextrose agar. All of the strains grew slowly on cornmeal-dextrose agar, and this medium offered no advantage for either sporulation or production of pigment. FIGURE 1, A illustrates the characteristic depauperate microscopic morphology on these media. Irregular mycelia and chlamydospores were the only structures usually seen.

Studies on special enriched media: On all these media the growth of all strains was heavier, more folded, and showed a more powdery to downy surface growth than that seen on the routine media described above. In several cases, a few microconidia were produced in the aerial mycelium. Strain No. *365*, which showed microconidia on the routine media, grew more rapidly and produced a heavier, more folded colony on the enriched media. These studies indicated that many crude natural products contain factors which enhance growth and stimulate spore production of *T. violaceum*.

Studies on synthetic media with the ten thiamine deficient strains: Although all of these strains utilized inorganic nitrogen to a very

TABLE I

LIST OF STRAINS STUDIED; THEIR SOURCE, AND CULTURAL CHARACTERISTICS ON SABOURAUD DEXTROSE AGAR (DIFCO)

Organism	Source	Colony characteristics at 4 weeks on Sab. dex. agar	Pigment	Spores	Vegetative mycelium
T. violaceum *369–5* *369–6*	Recently isolated strains.	Small; raised, moist and glabrous with finely verrucose surface.	Deep purple throughout.	Chlamydospores very numerous, many in chains.	Thin, irregular and fragile.
T. violaceum *364* *367* *368* *369* *369–2* *369–4*	From various stock culture collections. Isolated in past 3 years.	Small, heaped colonies, irregularly folded, some with flat spreading areas; partially glabrous, but flat areas covered with short surface down.	Only 2 strains (*367–368*) retained violet pigment at edges and on reverse, others colorless to grey.	Chlamydospores numerous, terminal and intercalary.	Thin, irregular and fragile.
T. violaceum *365*	Strain Leontieff, Central Bureau Fungus Cultures, Netherlands.	Large; flat with regular radial grooves, white fluffy surface growth.	White surface; clear yellow on reverse.	Microconidia very numerous en thyrse and en grappe. Rare macroconidia.	Regular and well formed.
T. violaceum *365a*	Mutant from a single spore culture of *365*.	Small, raised, moist and glabrous with finely verrucose surface.	Deep purple throughout.	Chlamydospores numerous.	Thin, irregular and fragile.
T. glabrum *352*	Strain Engelhardt, Central Bureau Fungus Cultures, Netherlands.	Small; heaped center and flat border, tough; glabrous except for spiny outgrowths on surface.	Entire colony grey to tan.	Chlamydospores numerous.	Thin, irregular and fragile.

slight extent in the absence of thiamine, the growth of all strains was increased by the addition of thiamine to the NH_4NO_3 medium. The two most recently isolated strains, Nos. *369–5* and *369–6*, developed only a small amount of glabrous surface growth, but it was colored deeply with red-purple pigment. However, the older

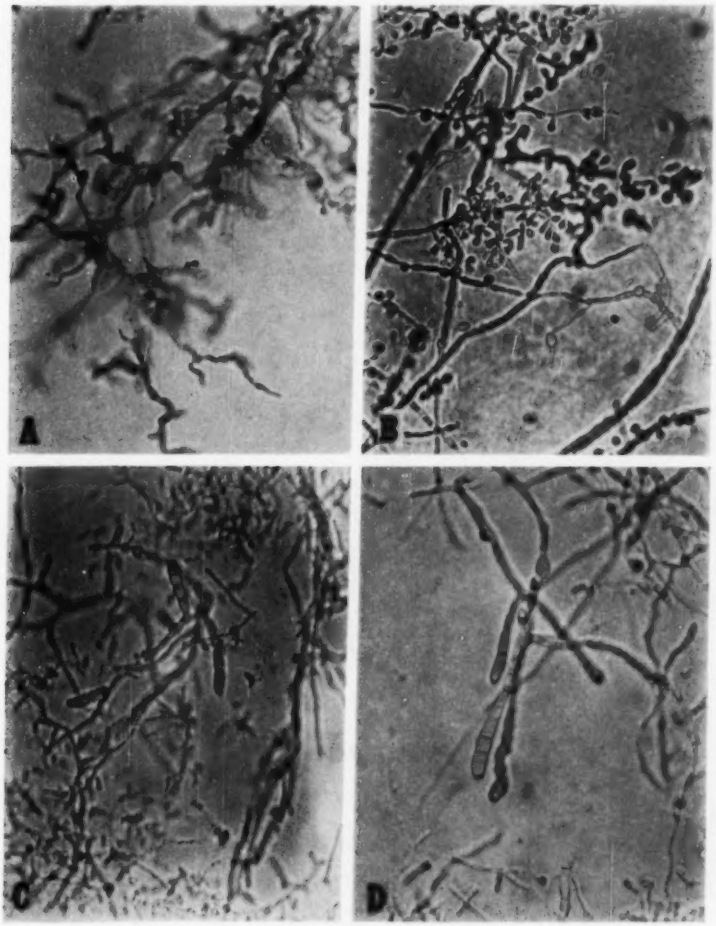


FIG. 1. A. Irregular mycelium and chlamydospores of *T. violaceum* on Sabouraud's dextrose agar (Difco). B. Microconidia of *T. violaceum* on thiamin-casein agar. C and D. Macroconidia of *T. violaceum* on thiamin-casein agar.

stock strains, Nos. *364, 367, 369, 369–2,* and *369–4,* as well as No. *365a,* the purple-pigmented strain derived from strain No. *365,* grew quite well on the thiamine-enriched NH_4NO_3 agar. After 4 weeks of growth the colonies averaged 20 mm. in diameter, some with a red to purplish pigment on reverse. A few of the strains

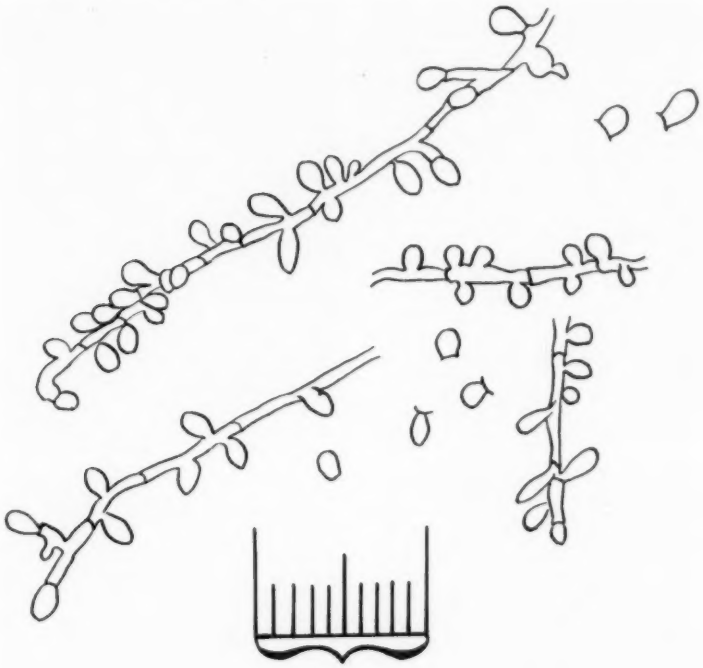


FIG. 2. Microconidia of *T. violaceum* (camera lucida).

developed considerable white, fluffy surface growth in which could be found numerous small, slender microconidia. Greater amounts of NH_4NO_3 (up to 4 times as much) did not increase the growth further.

Growth on the thiamine-enriched casein agar was similar in amount and appearance to the above. However, the amount of

growth and the production of spores were greatly stimulated by a five-fold increase in the quantity of casein. On such thiamine-enriched casein media, not only were numerous microconidia pro-

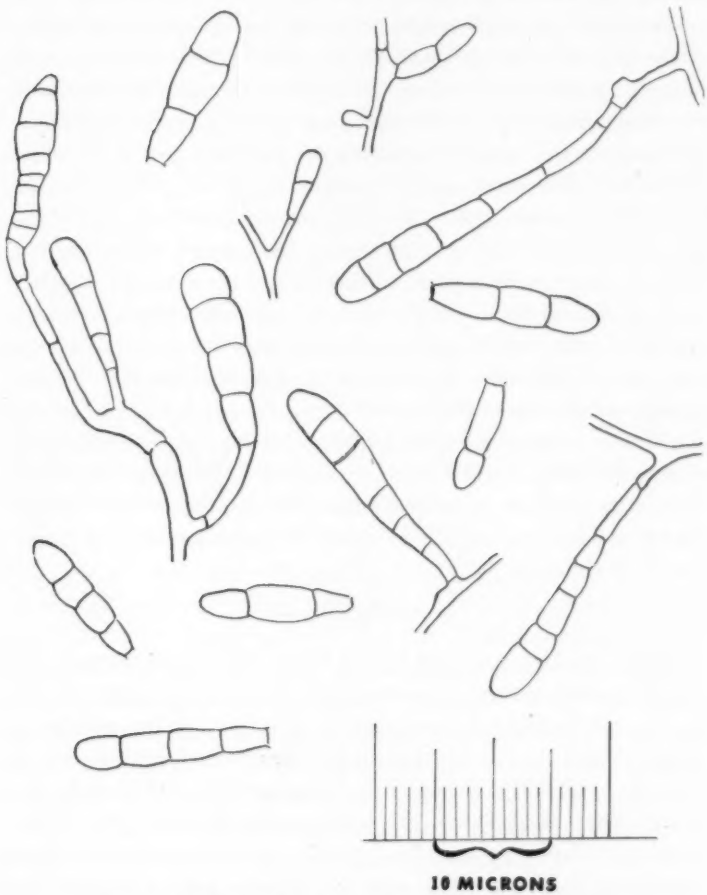


FIG. 3. Macroconidia of *T. violaceum* (camera lucida).

duced "en thyrse" and "en grappe" by several of the strains, but also the macroconidia of this species were observed for the first time. The macroconidia were elongate, 2- to 5-celled, smooth-walled, and hyaline. They were borne both terminally and laterally

on the mycelium. The walls were thin and frequently indented at the septa. These spores were clavate and resembled quite closely the macroconidia of *T. mentagrophytes* (FIG. 1, B, C, D, and camera lucida drawings, FIGS. 2, 3).

Studies on synthetic media with the histidine-deficient strain: Strain No. *365* differed from all the other strains studied in its ability to grow rapidly on routine media. The colonies produced were white and fluffy and showed a clear yellow pigment on reverse. Microscopically, numerous microconidia were apparent in the aerial mycelium. This strain showed no growth on NH_4NO_3 agar, but grew well on casein agar. The addition of l-histidine to NH_4NO_3 agar allowed the fungus to grow, but the amount of growth was small and largely submerged. Vitamins had no stimulatory effect; however the addition of other amino acids in combination with histidine further stimulated the growth and it was found that combinations of histidine with glutamic acid or aspartic acid allowed growth comparable to that obtained on a 0.2 per cent acid-digested casein agar. On such media, rapidly growing, heavily folded colonies with fluffy aerial growth developed. This aerial mycelium bore large numbers of microconidia and occasional macroconidia similar to those produced by several of the thiamine-deficient strains described above.

DISCUSSION

Studies by Langeron and Milochévitch (**17**) had suggested that specific factors present in natural substances were important for the normal growth and sporulation of certain of the pathogenic fungi. Nutritional experiments using chemically defined media, by Robbins *et al.* (**21**), Schopfer and Blumer (**24**), Burkholder and Moyer (**5**), Mackinnon and Artagaveytia-Allende (**18**), Arêa-Leão and Cury (**1**), and Georg (**13**), showed that some of the pathogenic fungi had deficiencies for vitamins and amino acids and were stimulated by other factors present in such natural products as peptones, liver and yeast extracts.

Not only do certain fungi require these substances for growth but the type of growth produced under conditions of adequate nutrition differs considerably from that observed on the commonly used media, where these growth substances were either absent or

present in inadequate amounts. *T. faviforme,* for example, usually has been described on Sabouraud's dextrose agar as having a slow, poor development; the colonies being small, moist, glabrous and consisting of poorly formed mycelium and chlamydospores. However, this species has been shown (**21, 18, 13**) to have deficiencies for thiamine, inositol, or pyridoxine or a combination of these vitamins, and when they were supplied in adequate amounts to the usual dextrose media, the development of rapidly growing downy to fluffy colonies with well-formed mycelium has been observed. In many cases under such conditions, the mycelium was found to bear numerous microconidia and macroconidia which previously had been considered rare or absent in this species (**12**).

In a similar manner, the slow-growing, glabrous nature of cultures of *T. violaceum* on Sabouraud's dextrose agar has been shown to result from an inadequate medium. In studies with the synthetic media described above it has been demonstrated that, for the majority of the strains studied (9 out of 10), thiamine (more specifically, the pyrimidine portion of thiamine) was the limiting factor in the growth of *T. violaceum,* and that organic nitrogen, in the form of amino acids, was necessary for good growth. Additions of adequate amounts of thiamine to an organic nitrogen medium such as a casein or trypticase dextrose agar changed the macroscopic and microscopic appearance of these cultures. Not only was growth more rapid for all strains, but the colonies were heaped and folded and a few of the strains developed a white, downy surface growth. Continued subculture on a thiamine-enriched, organic nitrogen medium permitted the development of microconidia (8 of 11 strains studied) and, in 4 of these strains, macroconidia also were produced.

It was apparent that adequate amounts of thiamine, which these strains required for good growth, were also important for sporulation. However, it was of interest to note that, of the strains studied, the completely glabrous stock strain, No. *352,* and the two recently isolated glabrous strains, Nos. *369–5* and *369–6,* could not be induced to produce aerial mycelium or conidia on thiamine-enriched, organic nitrogen media.

Because of the long list of synonyms which usually accompanies descriptions of *T. violaceum,* a review of the literature was under-

taken in order to clarify the taxonomic position of this species. Sabouraud states in "Les Teignes" (**23**) that he first isolated *T. violaceum* in 1892 from a case of cutaneous trichophytosis in a man returned to France from the Sudan. He had described the organism in 1892 (**22**) as "Trichophyton à culture violet foncé." In 1902 Bodin (**4**) gave the fungus the binomial *T. violaceum* Sabouraud. In 1910 (**23**) Sabouraud described *T. glabrum* which he considered as a fixed variety of *T. violaceum* and thus a species distinct from it. *T. glabrum* was characterized as growing more rapidly than *T. violaceum* and producing colorless to grey or brownish, flat, moist, glabrous colonies. Since such cultures resemble old glabrous colonies of *T. violaceum* which have lost their pigment, most workers consider the organism as a non-pigmented variety of *T. violaceum* and place it in synonymy with this species. As early as 1894, Sabouraud had described the development of white down and the presence of small lateral microconidia on some of his *T. violaceum* cultures. Truffi, in 1902, cited by Sabouraud in "Les Teignes," also described microconidia. Microconidia were redescribed for *T. violaceum* by Ota and Langeron in 1923 (**20**), and on the basis of these structures Langeron and Milochévitch in 1930 (**17**) suggested considering *Achorion violaceum* Bloch (1911), *Bodinia glabra* Ota and Langeron (1923), *Bodinia violacea* Ota and Langeron (1923), and *Sabouraudites violaceus* Ota and Langeron (1923) as synonyms of *Trichophyton violaceus* Sabouraud apud Bodin (1902).

In spite of the finding of microconidia in this species, Grigoraki (**15**) in 1925 suggested transferring it, along with many other usually non-sporulating species, to a new genus, *Arthrosporia,* because of the characteristic production by these cultures of large numbers of arthrospores (chlamydospores), and created the new combination, *Arthrosporia violacea.* Dodge (**10**) placed this species in his genus *Favotrichophyton,* because the moistness of the colony and the microscopic characteristics suggested the culture of *Trichophyton Schoenleini,* the etiologic agent of the disease favus. However, since Emmons' review of the classification of the dermatophytes in 1934 (**11**), in which natural groupings were made on the basis of the form of the spores and accessory organs, the old genus *Trichophyton* has been reestablished for most of these species.

Conidia were described for *T. glabrum* by Kato (**16**) in 1926, and Catanei in 1937 (**6**) described conidia in the downy and fluffy sectors of old cultures of both *T. violaceum* and *T. glabrum*. Catanei, who has studied many strains isolated in Algeria, where the fungus is common, considered the two as distinct species. He stated (**7**) that the ultimate loss of pigmentation of *T. violaceum*, which renders it similar to *T. glabrum*, is an alteration which does not persist after animal inoculation, as depigmentated strains of *T. violaceum* inoculated into the experimental animal may be recovered in the violet form.

Previous to the present study, macroconidia had never been clearly defined for *T. violaceum*. Ota and Langeron in 1923 (**20**) described and illustrated a "chlamydospore terminale" that was considered to be composed of a fusiform chain of chlamydospores attached to a hypha by a slender extension. These structures appear to have been abortive macroconidia. In the present studies, four of the strains examined produced structures which we believe may be considered macroconidia. These were highly irregular in size and shape, but their general clavate form and thin walls are in keeping with the macroconidia characteristic of the genus *Trichophyton*. Camera lucida drawings and photomicrographs are presented which define clearly their characteristics.

As a result of our studies, we believe that this fungus is correctly classified in the genus *Trichophyton*. The fact that most of the strains were microscopically similar and could produce similar spores, as well as the fact that they have similar nutritional requirements, suggests that they are of one species despite the fact that the colonies vary tremendously in form and pigmentation. Most of the species and variants mentioned above are probably colonial variants of the species originally described by Sabouraud and named *T. violaceum* by Bodin.

SUMMARY

1. Nutritional studies, Part I of this paper (**14**), had shown that of eleven strains of *T. violaceum* studied, ten had a partial deficiency for thiamine, and that stimulation of growth beyond that produced by thiamine was obtained with the addition of casein or certain peptones.

2. In a dextrose medium with a supra-optimum quantity of thiamine and either casein or certain peptones, rapidly growing colonies of *T. violaceum* were obtained, and in some strains the development of a white, downy surface growth containing microconidia was observed. Furthermore, in a few strains, structures which would appear to be macroconidia were seen. These are described in detail.

3. One strain, No. *365,* which was not vitamin-deficient but required the amino acid l-histidine, was morphologically distinct from the others. It would seem that its morphological characteristics are a reflection of its physiological aberrance, since there developed from a single-spore culture of this strain mutant sectors which had become sufficient for histidine, but had lost the ability to synthesize thiamine and had become morphologically similar to other thiamine-deficient strains of *T. violaceum* studied.

4. The classification of *T. violaceum* Sabouraud apud Bodin (1902) is reviewed, and the following synonymy is suggested:

Trichophyton à culture violet foncé, Sabouraud 1892 (**22**).
Trichophyton glabrum Sabouraud 1910 (**23**).
Achorion violaceum Bloch 1911 (**3**).
Bodinia violacea Ota and Langeron 1923 (**20**).
Bodinia glabra Ota and Langeron 1923 (**20**).
Sabouraudites violaceus Ota and Langeron 1923 (**20**).
Arthrosporia violacea Grigoraki 1925 (**15**).
Favotrichophyton violaceum Dodge 1935 (**10**).
Favotrichophyton glabrum Dodge 1935 (**10**).

Other possible synonyms of which we have not studied typical strains are:

Trichophyton marginatum Muijs 1921 (**19**).
Favotrichophyton violaceum var. *marginatum* Dodge 1935 (**10**).
Trichophyton violaceum var. *khartoumense* Chalmers and Macdonald 1915 (**8**).
Favotrichophyton violaceum var. *khartoumense* Dodge 1935 (**10**).
Trichophyton violaceum var. *coccineum* Ballagi 1926 (**2**).
Favotrichophyton violaceum var. *coccineum* Dodge 1935 (**10**).

ACKNOWLEDGMENT

The author wishes to express her graitude to Dr. Rhoda W. Benham of the Department of Dermatology, Columbia University, College of Physicians and Surgeons, for advice and assistance in this work.

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SOME LEAFSPOT FUNGI ON WESTERN GRAMINEAE—VI [1]

RODERICK SPRAGUE

(WITH 1 FIGURE)

Since completion of a fifth paper with the above title, there has been additional opportunity to study leafspot fungi on Gramineae from western states. G. W. Fischer and I made an extended tour of ten western states during late July and early August, 1950. In late August, some 80 numbers were gathered on San Juan Island, Wash., and I also obtained material from the forested hills of north central Washington.

As we continue to expand the known host range of some of the commoner fungi on western Gramineae, we encounter more minor to distinct variations in them. At least a preliminary discussion of some of these additions is needed to disclose the extent of variation in the species. In this, as in earlier papers, we have made no attempt to include mention of collections which merely add to the known host range. Such additions, because of the many species of grasses and fungi involved, become commonplace. Except in special cases, we have relegated such information to check lists (**15**) or general texts (**12**). The material we collected in 1950 and the collections from the San Juan islands contained many additions to the western fungus flora. We added almost 50 per cent to the known state host ranges from New Mexico, for instance, in about four days.

Hitchcock's manual (**4**) was used for host identification, but in the Rocky Mountain area it was supplemented by Harrington's text on the grasses of Colorado (**3**).

[1] Scientific Paper No. 1000, Washington Agricultural Experiment Stations, Institute of Agricultural Sciences, The State College of Washington, Pullman.

Cochliobolus boutelouae sp. nov.

Maculis brunneo-nigris, ellipticis, 2–5 × 0.8–1.0 mm.; peritheciis nigris, ostiolatis (10–15 μ diam.), sub-globosis, 200–250 μ diam.; ascis fusiformibus, brevi-stipitatis, hyalinis v. dilute chlorinis, 90–110 × 20 μ; ascosporulis 8, hyalinis, in asco spiraliter convoluta, filiformibus, 140–230 × 3.0–4.5 μ, 5–9 septatis.

Hab. in foliis vivis *Boutelouae gracilis* (H.B.K.) Lag., prope Raton, N. Mex. Typus est A.S. *20,726*, Herbarium, Dept. of Plant Pathology, The State College of Washington, Pullman. Legit R. Sprague et G. W. Fischer.

Spots dark brown to black, elliptical to sometimes linear, 2–5 × 0.8–1.0 mm.; perithecia coriaceous-pseudoparenchymatous, black, ostiolate (10–15 μ diam.), slightly beaked or depressed flask-shaped to subglobose, 200–250 μ diam.; asci fusiform or more or less subcylindrical, short-stipitate, hyaline to dilute chlorine, 90–110 × 20 μ but many are smaller and immature; ascospores mostly 8 in an ascus, arranged in a tight coil, filiform with both ends rounded and blunted, hyaline, at first aseptate but becoming faintly 5- to 9-septate, 140–230 × 3.0–4.5 μ.

On living leaves of *Bouteloua gracilis* approximately ten miles south of Raton, N. Mex.

This fungus causes a dark brown, almost black, charred-appearing lesion on living leaves of blue grama. The lesions are first discolored, later darker, finally nearly black. The spots extend across the width of the narrow leaf. While they are usually near the tip, some of them occur toward the middle portion of the leaf or are scattered elsewhere. Some of the linear, and usually sterile spots, may not cover the entire width of the leaf but are restricted to the area between leaf veins.

Strangely enough, no conidial stage of this fungus has been found. While *Helminthosporium buchloës* Lefebvre and A. G. Johnson (**6**) was noted on blue grama in the same general area, it was not noted in this material.

C. boutelouae appears to be an active parasite. We have observed linear spots on blue grama at frequent intervals, but this is the first collection seen in which a fungus has been found sporulating. This particular species of *Cochliobolus* differs from other members of the genus (**2**) in the smaller spores (FIG. 1, A).

Robillarda muhlenbergiae sp. nov.

Maculis diffusis, stramineis; pycnidiis erumpentibus v. subsuperficialibus, sub-gregariis, brunneis, fragilibus, globosis, ostiolatis (± 6 μ diam.), 60–200 μ diam.; pycnidiosporulis cylindraceis, rectis v. sub-curvulis, apicibis rotundatis, medio 1-septatis, 12–16 × 3.4–3.8 μ, basibis sub-acutis, 3–4 setaceis, setis 8–13 × ± 0.5 μ, hyalinis.

Hab. in foliis aridis basi culmorum *Muhlenbergiae filiformis* (Thurb.) Rydb., Modoc Natl. For., Calif. Typus est A.S. *20,625*, Herbarium, Dept. of Plant Pathology, The State College of Washington, Pullman.

Spots diffuse, straw-colored; pycnidia more or less grouped, erumpent to subsuperficial, brown but appearing very pale, virtually translucent under critical illumination, extremely variable in size, 60–200 μ diam., mostly globose but flattened slightly, ostiole small and inconspicuous, about 6.0 μ diam.; pycnospores hyaline, cylindrical, straight, sometimes curved, medianly 1-septate, 12–16 × 3.4–3.8 μ, apex blunted, base pointed (somewhat paliform) with 3–4 hyaline setae which are 8–13 × ± 0.5 μ.

On dried basal leaves of vigorous plants growing in a moist draw near the (discontinued) Tree Planting Station in the Modoc Natl. Forest in the hills near Goose Lake in California, July 28, 1950.

This fungus was compared critically with *Robillarda agrostidis* Sprague in Sprague and Cooke (**14**). The spores of the former (FIG. 1, B) are broader and shorter than those of *R. agrostidis* so that they appear considerably more blocky in outline. The pycnidia of *R. muhlenbergiae* are thinner and somewhat more fragile than the stouter, if brittle, ones of *R. agrostidis*. *R. muhlenbergiae* may be weakly parasitic, at least the pycnidia are in leaves which have only recently died and are on otherwise vigorous plants. From their orientation in crushed spore masses, I have concluded that the spores are borne blunt end out. This reverses my opinion of *R. agrostidis*. It appears more likely that the setae in the spores of this species also occur at the basal end.

Phyllosticta bromivora sp. nov.

Maculis ellipticis, brunneis, centro pallidis; pycnidiis erumpentibus, pallido-brunneis, pseudoparenchymaticis, ostiolatis, globosis v. ellipticis, 80–115 × 65–110 μ; pycnidiosporulis in cirrhis, cylindraceis v. cylindraceo-ellipticis, biguttulatis, hyalinis, 6–11 × 3.0–3.8 μ.

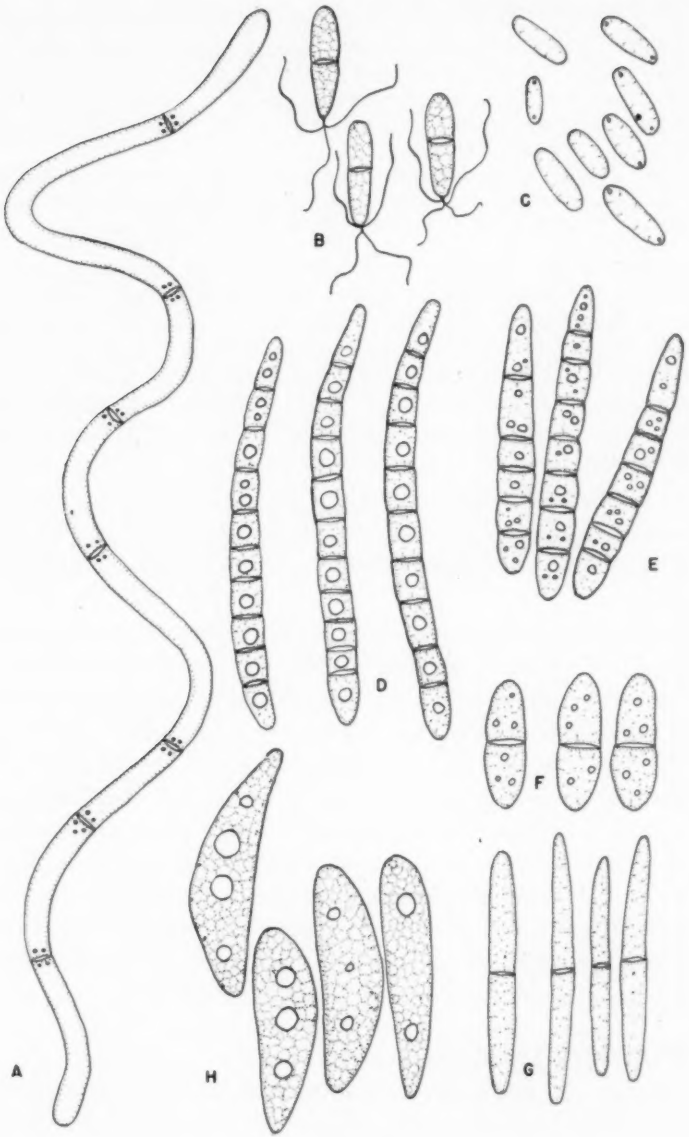


FIG. 1.

Hab. in foliis vivis *Bromi ciliati* L., prope Chama, Neo-Mexicana. Typus est A.S. *20,669*, Herbarium Dept. of Plant Pathology, The State College of Washington, Pullman. Legit R. Sprague et G. W. Fischer, Aug. *2*, 1950.

Spots elliptical, becoming paler in the center; pycnidia numerous, erumpent, thin-walled, pale brown, almost translucent under high magnification, pseudoparenchymatous, ostiolate, globose to elliptical, more or less in lines, 80–115 × 65–110 μ (frequently about 100 × 80 μ); pycnospores sometimes produced in short cirrhi, short cylindrical to cylindrical-elliptical or less often slightly pointed at one end, sometimes bi-guttulate, hyaline, 6–11 × 3.0–3.8 μ.

On a small plant of *Bromus ciliatus* in dry mixed woods in the mountains 5 miles n.e. of Chama, New Mex., Aug. *2*, 1950.

In a key to the species of *Phyllosticta* on grasses (**12**) it would appear that *P. miyakei* Sydow (on rice) is closest to *P. bromivora*, except that the oriental species has black pycnidia and fusoid spores. The recently described *P. helenae* (**13**) has larger pycnidia and smaller spores than the New Mexico form. We compared this with Rocky Mountain material of *Septoria nodorum* Berk., *Stagonospora bromi* Sm. and Ramsb. and of the pycnidial stage of *Septogloeum oxysporum* Sacc., Bomm. and Rouss., all on *B. ciliatus*, and concluded that *P. bromivora* was not part of the life cycle of any of these forms. As in most collections of *Phyllosticta*, we found a few 1-septate spores. But over 99 per cent of them were nonseptate (FIG. 1, C). The type material is somewhat scanty but the original mount, containing a number of pycnidia and many spores, is also preserved with the type at Pullman.

Stagonospora mariae sp. nov.

Maculis griseo-brunneis, diffusis; pycnidiis nongregariis, pseudoparenchymaticis, brunneis, erumpentibus, depresso-globosis, ostiolatis, 60–138 μ; pyc-

FIG. 1. All figures reproduced at a magnification of approximately × 1000. A. Ascospore of *Cochliobolus boutelouae*, partially uncoiled after emerging from the ascus. From type. B. Pycnospores of *Robillarda muhlenbergiae*. From type. C. Pycnospores of *Phyllosticta bromivora*. From type. D. Pycnospores of *Stagonospora mariae*. From type. E. Pycnospores of *Stagonospora vexatula* on *Deschampsia caespitosa* near Eagle Nest, N. Mex. (A.S. *20,683*). F. Pycnospores of *Ascochyta graminea* on *Hilaria jamesii* near Colfax, N. Mex. (A.S. *20,724*). G. Pycnospores of *Septoria andropogonis* on *Stipa robusta* near Colfax, N. Mex. (A.S. *20,720*). H. Conidia of *Colletotrichum graminicola* on *Catabrosa aquatica*, north of Burns, Oregon (A.S. *20,632*).

nidiosporulis filiformi-clavulatis, curvulis, apicibis et basibis sub-acuminatis, contextu guttulato, 9–10-septatis, constrictis ad septa, hyalinis, 55–67 × 5.0–5.3 μ.

Hab. in foliis vivis *Agrostidis oregonensis* Vasey, Oceanographic Laboratory prope Friday Harbor, Wash. Typus est A.S. *24,301.*

Spots on living leaves gray-brown to ashy, diffuse and obscured by insect action and secondary molds; pycnidia scattered, pseudoparenchymatous, dark brown, erumpent, depressed-globose, ostiolate with the ostiolar end tending to weaken and break away under the internal pressure of the spore mass, variable in size, 60–138 μ, mostly 100–120 μ; pycnospores coarse, filiform-clavulate, curved to nearly straight but most of them curved towards the apex, base and apex acuminate but not strictly sharp pointed; contents consists of 1, rarely 2–3, guttulae which are about 2 μ diam. in each cell, moderately constricted at each of the 9–10(7–10) septations; the cells of the spores, except the terminal ones, are nearly as wide as long, hyaline, spores 55–67 × 5.0–5.3 μ.

In foliage of living leaves of *Agrostis oregonensis* Vasey, Oceanographic Laboratories near Friday Harbor, Wash. The material of the type is not abundant, but the slide from which the description was made contained numerous, if scattered, pycnidia in ashy to grayish-brown diffuse lesions. The lesions were partially overrun by *Cladosporium herbarum* Lk., an organism which thrives in the saline air of the San Juan Islands. A trace of *Colletotrichum graminicola* (Ces.) Wils. was also noted in one mount. All indications are that the newly described species of *Stagonospora* is not actively parasitic but shows some indications of being able to invade living tissue.

St. mariae is the hyaline counterpart of a species of *Phaeoseptoria.* It was compared with the fragmentary type of *Ph. calamagrostidis* Sprague (**7**) and of *P. festucae* Sprague (**7**) before deciding that it was distinct. Its spores are definitely hyaline, and its inclusion in *Phaeoseptoria* would be on the premise that they were immature. They did not so appear and, unless brown coloring appears in them, they should be excluded from *Phaeoseptoria.* We have had several experiences wherein hyaline-spored material became brown on aging in the herbarium. After nearly six months these are still strictly hyaline.

St. mariae has smaller pycnidia than *P. calamagrostidis,* but their size is close to those of *P. festucae.* The spores (FIG. 1, D) are

about the same size as those of *P. calamagrostidis,* if slightly broader, but have stronger constrictions at the septations, are less vermiformous, somewhat more tapered at the terminals, and have coarser contents. They definitely resemble a hyaline phase of *Phaeoseptoria.* More material is needed of all of these coastal forms.

We could find no description of either *Septoria* or *Stagonospora* that fitted the description of *St. mariae,* although *St. vexatula* shows some resemblance (compare FIG. 1, D and 1, E). We prefer *Stagonospora* to *Septoria* for inclusion of this fungus.

St. mariae is named for Mary Willis Sprague who accompanied me on the collecting trips in the San Juan Islands during August, 1950.

ASCOCHYTA BRACHYPODII (Sydow) Sprague and A. G. Johnson occurs on dead leaves of *Festuca ovina* var. *brachyphylla* (Schult.) Piper at an elevation of 11,500 ft. on Pikes Peak, Colo. (A.S. *20,671*). The spores are uniformly cylindrical to slightly irregular, 17–21 × 3.7–4.4 μ, and therefore are nearly intermediate in size between *A. brachypodii* and *A. sorghi.* Their appearance is close to that of the spores of some material of *A. brachypodii* collected on *Stipa comata* a number of years ago in Montana (**12,** Fig. 8, L). Fischer and I collected material on alpine grasses to the top of Pikes Peak but did not find very much of pathological-mycological interest at any elevations above 12,000 ft. This has usually been our experience elsewhere. The short season, drying winds, and intense sunlight appear to mitigate against development of parasitic fungi at extreme alpine levels. Saprophytic forms, especially ascomycetes, thrive on frost-killed leaves, however. Farther down the slope of Pikes Peak powdery mildews, rusts, and a few smuts were common in shaded or sheltered places, even as high as 12,000 ft. But here, as elsewhere, the greatest development of spots occurs in the sub-alpine and adjacent alpine meadow areas. *Selenophoma donacis* (Pass.) Sprague and A. G. Johnson, it might be mentioned, caused a well-defined spot on *Poa arctica* R. Br. at 11,500 ft. on the peak.

Some interesting material of *A. brachypodii* was collected in quantity on necrotic leaves of growing plants of *Schedonnardus paniculatus* (Nutt.) Trel. in the desert northwest of Arroyo Hondo,

N. Mex. (A.S. *20,660*). The pycnidia were numerous on the bleached leaves, and they produced spores in loose tendrils when placed in water mounts. Immature aseptate spores were elliptical with small guttulae at both ends. Septate spores were typically fusoid, 1-septate, hyaline, 15–20 × 4.6–5.2 μ. Some of the pycnidia were produced in white lesions on living leaves and apparently were the result of parasitic activity. The local desert had been visited by frequent rains, and leaf spots were amazingly prevalent.

ASCOCHYTA GRAMINEA (Sacc.) Sprague and A. G. Johnson, reported only from grama grass and Bermuda grass, was found on dried basal leaves of *Muhlenbergia torreyi* (Kunth.) Hitchc. about ten miles south of Raton, N. Mex., Aug. 4, 1950 (A.S. *20,693*). The spores, which were borne in small pycnidia, varied from capsular to broadly fusiform, 17–20 × 5.0–6.9 μ. They were hyaline but had the smoky tint of *A. graminea*. Some of the spores with pointed ends resembled *A. hordei* Hara on *Holcus lanatus* (**16**, Fig. 2, F and **12**, Fig. 10, C).

There is also a specimen of *A. graminea* on *M. racemosa* (Michx.) B.S.P. from Cimarron Canyon, N. Mex. (A.S. *20,758*), which appears to be somewhat immature. The nonseptate spores are capsular with more or less pointed ends, 11–15 × 4.3–5.0 μ. They cling together in smoky masses and are obviously immature. The pycnidia are thin-walled, pale brown to brown.

Another collection of *A. graminea*, on *Hilaria jamesii* (Torr.) Benth. (A.S. *20,724*) in this instance, was found along the Vermejos River near Colfax, N. Mex., in the same general region as those above mentioned. The spores were 17–20 × 6.6–7.5 μ and were moderately constricted at the central septum and tapered somewhat toward the narrowed but usually rounded ends (FIG. 1, F). The spores were also lightly tinted, possibly more yellow than smoky. Their contents were not completely homogeneous but contained a few scattered oil drops scarcely 1 μ in diameter. The fungus was associated with *Hendersonia culmiseda* which had 3-septate, fusiform spores 10–18 × 5–7 μ. These averaged smaller than the *Ascochyta* spores and were borne in much smaller, somewhat paler pycnidia. *Hendersonia stipae-pennatae* Fautr., which has multiseptate, cylindrical spores, was also associated.

The material on *Hilaria* is the result of very weak parasitic activity, if at all. The *Ascochyta* pycnidia were in vague discolored areas on the perennial leaves of this strictly desert grass. However, we did find *A. graminea,* on *Bouteloua gracilis,* near Eagle Nest, N. Mex., at the head of Cimarron Canyon (A.S. *20,727*), that caused definite lesions. The spots were elongate, gray to straw-colored with faintly pinkish borders. The pycnidia measured as much as 200 × 100 μ and the spores, 17–21 × 5.0–6.5 μ. This material was collected very near the type locality of *A. boutelouae* Fairman, a fungus that is now considered to be the same as *A. graminea* (**16**).

ASCOCHYTA HORDEI Hara was associated with *Hendersonia crastophila* Sacc. on moldy leaves of living plants of *Stipa lettermanii* Vasey in a grass-covered valley near Macks Inn, Ida. (A.S. *20,595*). The subhyaline to hyaline spores of *A. hordei* were mostly 20–21 × 6.0–6.5 μ and were definitely tapered from the central septum to the apices.

There is another collection of *Ascochyta* sp. on *Bromus ciliatus* L. from the Kit Carson Natl. Forest, near Taos, N. Mex., which differs from *A. hordei* in the somewhat narrower, truly cylindrical spores. It does not key out to any species of *Ascochyta* on grasses (cf. **12, 16**) and, unfortunately, the material is too scanty to justify describing and naming. It is part of the confusing array of forms on *B. ciliatus* in the Rocky Mountains.

ASCOCHYTA SORGHI Sacc. on *Alopecurus aequalis* Sobol occurs along a creek in Kit Carson Natl. Forest near Taos, N. Mex. The pycnidia are very thin-walled, pale-golden color under transmitted light, sub-superficial, and with small ostioles. They had probably developed rapidly during the unseasonably prolonged wet period in July and early August. This would account for the fragile nature of the pycnidia. The spores were 10–15 × 2.2–2.8 μ. They were somewhat large for *A. phleina* Sprague (**8**) and within the range of *A. sorghi.* The pycnidia were on dried basal leaves, and the fungus may have been only weakly parasitic.

The same kind of fungus was found on *Agropyron trachycaulum* (Lk.) Malte at Cumbres Pass, N. Mex., with narrow spores, 13.7–17.5 × 2.2–2.6 μ (A.S. *20,729*).

ASCOCHYTA UTAHENSIS Sprague was collected on *Agropyron trachycaulum* at Targhee Pass, Idaho, with typical spores except for the Apiocarpella-like position of the septation. The spores were blunt at both ends, cylindrical but with the septation about one-third of the distance from the smaller end. The spores were sometimes slightly constricted at the septum. This, plus their broad dimensions, gave them a somewhat swollen appearance. They measured 20–27 × 9.8–11 μ which compares closely with the size of the type of *A. utahensis* (**9**). The material from Targhee Pass had globose, golden-brown pycnidia which had small ostioles opening hypophyllously, although the pycnidia could be seen from either leaf surface. They measured 115–170 μ diameter. This collection is confusing, because, except for the acentral septation, the typical spore of this species matches those of *A. utahensis*. In addition, the lesions are elliptical, brown with paler centers, and the fungus is evidently actively parasitic.

We recently reported *Apiocarpella agropyri* Sprague in Greene (**12**) on wheatgrass. But the spores of this species were smaller, 17–22.5 × 2.8–4.2 μ, and pointed at one end. However, still more recently, we assigned material on *Poa ampla* Merr. to *A. macrospora*. This fungus had spores with both ends blunted in most cases. They were nearly as wide (8.5–10 μ) as those from *A. trachycaulum*, but some of the spores from *Poa* were typically pointed as in *Apiocarpella*. The ones we are considering now, however, seem to be only atypical *A. utahensis*. Along this same vein, mention should be made of very similar material on *Agropyron spicatum* (Pursh) Scribn. and Sm. found east of West Yellowstone, Mont. [in Wyoming], with spores 20–23 × 9.4–10.0 μ (A.S. *20,765*).

A. utahensis was also found on *Elymus condensatus* Presl at Silvies, Oregon, on July 28, 1950 (A.S. *20,611*). The spores in this material are exceptionally large, 29–40 × 11–13 μ, are hyaline and 1- sometimes 2-, less often 3-septate. The spots are elliptical, brown-bordered with light fawn centers. The lighter centers enables one to distinguish them, to some extent, from the brown blotch disease caused by *Septoria infuscans*. The spots, or eyespots, of *A. utahensis* average 3–5 × 0.7–1.0 mm. diam. and are sometimes prevalent enough to cover most of the leaf surface of the material.

The fungus is actively parasitic. The Silvies material shows some resemblance to *Stagonospora simplicior* (**10, 11, 12**) but lacks the coarse spore contents of this species. The material on *E. condensatus* appears to be developing into a true *Stagonospora*. Further study with overwintering material of *A. utahensis* may disclose that it is a species of *Stagonospora*. It should be noted in passing, however, that fungi on the large leaves of the giant wild-rye have a tendency to grow large. Perhaps this alone accounts for the unusual development of this material.

PHYLLOSTICTA sp. was found on drying leaves of *Melica subulata* (Griseb.) Scribn. in woods at the Oceanographic Laboratories, Friday Harbor, Wash., Aug. 17, 1950 (A.S. *20,593*). The spores were bacillar-shaped, 2–3 × 0.7–0.9 μ, borne in sub-superficial brown pycnidia, 60–90 μ diam. These were associated with brown spots in living leaves, but the pycnidia were not in the sterile spots but in adjacent dried tissue. The fungus is probably the drought- and heat-retarded microspore phase of a species of *Septoria*, such as *S. avenae* Frank.

PHAEOSEPTORIA POAE Sprague was found on dead leaves of *Poa pratensis* L. at Pullman, Wash., on March 29, 1950. This second collection of the fungus has light brown, filiform-clavulate spores which are 5- to 7-septate, 45–61 × 2.2–2.8 μ as compared to 50–77 × 2.1–2.4 μ in the type (**8**). We also found *P. poae* on *Poa ampla* along the north fork of the Laramie River, Wyo. The spores were sub-hyaline, 50–70 × 2.4–3.0 μ, but a few were swollen in the middle and were then as wide as 3.8 μ (A.S. *20,690*). An alpine collection of *Phaeoseptoria* on *Poa fendleriana* (Steud.) Vasey had nearly superficial coarse black pycnidia containing spores 50–130 × 2.5–3.0 μ. The spores were 5- to 8-septate and resemble *P. airae* (Grove) Sprague more than *P. poae*.

P. poae was found on dead leaves of *Phleum pratense* L. near the seashore at San Juan State Park on San Juan Island, Wash., Aug. 15, 1950 (A.S. *20,769*). Scattered black pycnidia bore sub-hyaline narrowly filiform-clavulate, 3- to 7-septate spores 40–60 × 2.1–2.7 μ.

PHAEOSEPTORIA FESTUCAE Sprague occurs on dead leaves of *Agrostis scabra* Willd. in the Kit Carson Natl. Forest near Taos,

N. Mex. (A.S. *20,668*). The spores were yellow, clavulate-filiform, 7-septate, 45–67 × 2.5–3.8 μ.

SEPTORIA ANDROPOGONIS J. J. Davis causes fuscous, later buff elongate spots with white centers on leaves of *Stipa robusta* Scribn. near Colfax, N. Mex. (A.S. *20,720*) and also n.w. of Arroyo Hondo, N. Mex. (A.S. *20,730*). While we recently reported this species on *S. robusta* (**11**) the material from Colfax is atypical. The pycnidia are elongate to globose, sometimes 230 × 80 μ in the extreme, and where several occur in lines the bodies resemble narrow rust pustules. Other pycnidia in the same collection are typically subglobose to globose. The spores in both kinds of pycnidia are the same but they are not typical of *S. andropogonis* (FIG. 1, G). They are 1-septate, 30–42 × 3.2–3.8 μ, slightly narrowed toward their blunt base and pointed to almost blunt at the apex. The spores resemble those of *S. calamovilfae* to some extent. We consider them to be swollen spores of *S. andropogonis* on the basis of comparison with collections of this fungus on other hosts. They are closer to this species than to *S. secalis* var. *stipae* which is common on several other species of *Stipa* in the plains region.

SEPTORIA AVENAE Frank was common on *Trisetum montanum* Vasey, a new host, in the woods in Kit Carson Natl. Forest near Taos, N. Mex. (A.S. *20,706*). The spores were 25–34 × 2.5–3.1 μ. We have come to recognize *S. avenae* as the cause of one of the common leafspots of grasses in the western forested mountains.

SEPTORIA CALAMAGROSTIDIS (Lib.) Sacc. occurs on leaves of *Trisetum spicatum* (L.) Richt., a recently reported host (**15**), at about 10,000 ft. elevation on Mt. Peale, Utah, and at 11,200 ft. elevation on Pikes Peak, Colo. The spores in both collections had the typical filiform shape of this species, those from Colorado measuring 50–67 × 1.3–1.6 μ (A.S. *20,682*). The same fungus was also found on *Trisetum montanum* Vasey along Brooks Lake road in the Washakie Natl. Forest, Wyo. (A.S. *20,743*). It was also found on this host on the north fork of the Laramie River, Wyo. (A.S. *20,748*). The spores in the last-mentioned collection were as long as 67–80 × 1.3–2.2 μ.

SEPTORIA INFUSCANS (Ell. and Ev.) Sprague was found on *Elymus canadensis* L. near Cimarron, N. Mex. This location lies

some distance s.e. of any other collection known. In addition, the host is new and the collection not at all typical. The spores are curved, 1- to 3-septate, cylindrical-clavulate and extremely variable in dimensions from 10 × 2.5 μ to 50 × 4.5 μ. The lesions are fuscous to gray-brown, as in *S. infuscans,* and the pycnidia are very obscure. This tends to eliminate *S. elymi* f. *elymina, S. avenae* f. sp. *triticea* T. Johnson and *S. agropyrina* Lobik (**12**, pp. 215, *222, 233, 237*). The specimen was collected after a heavy and prolonged rainy period. The fungus was partially overrun by secondary and tertiary molds which apparently interfered with its normal development.

SEPTORIA NODORUM Berk. continues to be found on more and more hosts in the western mountains. It was collected on *Melica subulata* (Griseb.) Scribn. in buff to brown spots in the woods in Idaho east of Farmington, Wash., in a private park called Skyline Drive (A.S. *20,571*). This, like recently reported material on *Melica* (**9, 11**), has spores which are mainly 1-septate. The species was also found on *Melica bulbosa* Geyer on Mt. Peale, Utah (A.S. *20,652*).

S. nodorum was present on *Bromus ciliatus* in Cimarron Canyon, N. Mex. (A.S. *20,680* and *20,722*), following the prolonged rains mentioned above. The lesions on the leaves were elliptical, deep chocolate brown, later fading to buff in one collection (A.S. *20,680*) and were associated with leaf rust in the other (A.S. *20,722*). The pycnidia were globose, thin-walled, 100–130 μ diam., and the spores were mostly 1-septate but a few were 3-septate. They measured 17–22 × 2.5–3.0 μ. A third collection from Kit Carson Natl. Forest, N. Mex. (A.S. *20,733*), was similar with spores 15–20 × 2.5–3.4 μ. All of these collections had the typically blunted base and tapered apex of the spores of *S. nodorum*. The lesions were not as deeply purple-brown, perhaps, as those of *Stagonospora bromi.*

A second collection of *S. nodorum* on *Festuca subulata* Trin. from Washington state has somewhat fusiform spores 18.7–22.5 × 3.7–3.9 μ borne in ashy-buff to tawny spots. Some of the spores are 3-septate. This collection found at the Oceanographic Laboratories, Friday Harbor (A.S. *24,300*), resembles the somewhat atypical material found in the Chelan Natl. Forest a few years ago

(9). Another collection at San Juan State Park, San Juan Island, Wash. (A.S. *24,332*), had fusiform spores 17.5–23.8 ×3.3–4.4 μ.

Septoria nodorum occurred in association with *Puccinia montanensis* Ellis on *Agropyron pseudorepens* Scribn. and Sm. in the Cimarron Canyon, N. Mex. (A.S. *20,716* and *20,717*). The spores were 15–20 × 2.5 μ and were not mature.

A fuscous lesion on *Elymus glaucus* Buckl. near Albany, Wyo. (A.S. *20,747*), bore pale pycnidia with cylindrical 1-septate spores, 17–25 × 2.5–3.0 μ. This also appears to be *S. nodorum*.

SEPTORIA AGROPYRINA Lobik caused a spot and blotch on the leaves and stems of a sterile hybrid grass at Agua Fria, N. Mex. (A.S. *20,705*). Only a few of the pycnidia were mature. These contained spores which were curved, 3-septate, filiform-clavulate, pointed at the apex and tapered at the base, 50–60 × 2.5–3.0 μ. In assigning them to *S. agropyrina*, we considered a number of other species before arriving at our somewhat unsatisfactory disposal of the material. The spores somewhat resemble *S. andropogonis* f. *sporobolicola* Sprague but are slightly stouter than the latter and the host is atypical. Everything else considered, one is inclined to place this in the common species *S. agropyrina*. The host, as mentioned, is a hybrid that keys to *Elymus macounii* Vasey which is now known as a sterile natural hybrid between *Agropyron trachycaulum* and *Hordeum jubatum*. However, while the ripening heads of the Agua Fria material segment as in *E. macounii*, the awns are uniformly about 2 cm. long. This gives the heads a much more strongly bearded appearance than in typical *E. macounii*. It is suspected that this particular hybrid has *Elymus canadensis*, rather than *A. trachycaulum*, as one of the parents. It should be also stated that *Sitanion hystrix* was common in this area. Hybrids involving it (*S. hansenii*) were noted. However, specimen A.S. *20,705* had none of the bifid glumes of *S. hansenii*, nor were the awns long enough. Fischer and the writer found a most confusing array of evident hybrids in this northern New Mexico region. Some of these hybrids have not been officially recognized.

Septoria passerinii was considered in comparing with the above-mentioned material, because one of the parents was probably *Hordeum*. I rejected this fungus, however, because the spores seemed to be too long and the ends were too tapered. However, we have

seen somewhat similar material from Minnesota on *Hystrix* with spores 55–64 × 1.8–2.4 μ (**8**). This we assigned to *S. passerinii*. The Minnesota collection, however, had spores somewhat more filiform and less clavulate than the New Mexico specimen. As a result of the many collections of *Septoria* made on plains country grasses during the past few years, it is now very apparent that a critical study is needed of this complex group comparable to that done with far western species of *Septoria* (**12**). Until such study can be made, it will be our endeavor to assign the highly variable collections to the nearest recognizable species.

STAGONOSPORA VEXATULA Sacc. was reported (**10**) on *Deschampsia caespitosa* (L.) Beauv. near Plummer, Idaho (C.S. *3969*). The immature spores were 3-septate, 30–40 × 4.5–5.5 μ. Some time later we found some mature material from the same location, collected on the same day, which had not been examined earlier. The spores were cylindrical to fusiform, sometimes flattened on one side, base blunted, the apex pointed. The yellowish spores were 4- to 7-septate, 30–48 × 5.5–6.0 μ. The fungus appeared to be somewhat parasitic. We also have material of the same species on the same host obtained near Eagle Nest, N. Mex. (A.S. *20,683*). The spores (FIG. 1, E) were very similar to the Idaho material, long fusiform shape, 40–48 × 5.0–6.25 μ, 4- to 7-septate borne in large pycnidia.

GLOEOSPORIUM MEINERSII Sprague (**10**) was collected on living leaves of *Phleum alpinum* L., a new host, on the middle fork of Prince Creek, Chelan Natl. Forest, Wash., July 18, 1950 (A.S. *20,587*). The lesions were broader than in the type and extended the full width of the leaf for several centimeters longitudinally. The spores were the same kind as in the type, measuring 8.5–12.5 × 3.0–3.8 μ and were produced in quantities. The same fungus was found in the same location on *Poa nervosa* (Hook.) Vasey. *G. meinersii* var. *alpina* was collected on *P. alpina* L., the type host, at Togwotee Pass, Wyo., Aug. 10, 1950 (A.S. *20,639*). The spores were the same kind as in the type (**10**) from Colorado. A collection on *P. epilis* Scribn. at the same place (A.S. *20,745*) had spores 7.6–13.8 × 2.5–4.0 μ.

COLLETOTRICHUM GRAMINICOLA (Ces.) Wils. caused a widespread anthracnose of the basal culms and leaves of *Polypogon*

maritimus Willd. along the shores of Albert Lake north of Valley Falls, Oregon (A.S. *20,624*). There may be some uncertainty about the host determination. It keys to *P. maritimus* (**4**, p. 349). But Dr. Helen Gilkey, Oregon State College, found that all of the characters were those of *P. monspeliensis* (L.) Desf. except the ciliate-fringed lobes of the glumes. The plants were growing in alkaline soil. This may have accounted for their very small size, plus the almost omnipresent nature of the anthracnose. I am leaving this in *P. maritimus* for the present. *Polypogon* is unreported as a host-genus for *Colletotrichum*.

C. graminicola caused a fuscous to buff anthracnose on floating leaves of the brook grass *Catabrosa aquatica* (L.) Beauv. in a small creek about twenty miles north of Burns, Oregon (A.S. *20,632*). The material is atypical for *C. graminicola* because the spores are extremely large, 28–38 × 5.7–8.8 μ (FIG. 1, H). They are borne on acervuli which have an abundance of sporodochial tissue but from which only a few short setae arise. Typical *C. graminicola* has spores averaging 18–26 × 3–4 μ while those of *C. falcatum* are 20–27 × 4–5 μ. No mention has been located of any collections of *C. graminicola* with spores of this size. However, because of the unusual habitat on floating leaves with abundant moisture, it is suspected that the spores of the fungus on *Catabrosa* are only swollen ones of the usually terrestrial *C. graminicola*. Another collection on the heads of the same host at Granby, Colo. (A.S. *24,326*), had yellow-hyaline spores 25–30 × 4.7–5.2 μ. The fruiting surface had numerous stiff setae 25–50 μ long.

SEPTOGLOEUM OXYSPORUM Sacc., Bomm. and Rouss. was collected on *Agrostis thurberiana* Hitchc. by Lee Bonar in a moist meadow on the shore of Silver Lake, Carbon County, Wyo., at about 9000 ft. elevation, Aug. 9, 1950. The brown, elongate lesions had white masses of conidia in their centers. There was little of the carbonaceous growth (char spotting) that is often encountered on other hosts attacked by this fungus. No pycnidia were noted either. Dr. Bonar found that the spores measured 26–31 × 5–6 μ. Host determination was by Mr. M. A. Nobs, Univ. of California.

S. oxysporum occurred in great abundance on *Alopecurus alpinus* J. E. Smith in a small meadow across the highway from Targhee Forest Camp, Idaho, on Aug. 11, 1950 (A.S. *20,610*). The black

char spot was typical of the fungus. The conidial stage was scanty, but many immature perithecia were embedded in the spots. *Scolecotrichum graminis* Fckl. also occurred on this host but in no particular association with the char spot.

S. oxysporum was found on *Festuca idahoensis* Elmer west of Togwotee Pass in the Teton Natl. Forest, Wyo., Aug. 10, 1950 (A.S. *20,617; 20,640*). This material shows black charred areas on the filiform leaves. The spores are borne in pycnidia and are mostly 1-septate, somewhat blunted, 26–39 × 5.5–6.5 μ. This material has some resemblance to *Phleospora idahoensis* Sprague; but the spores in that species are narrower and longer, 44–53 × 4.6–5.6 μ, and there is little carbonization in the lesions. It is interesting to note, however, that the area where the char spot occurs is not a great distance from the type area of *P. idahoensis*. In addition, Fischer and I found *P. idahoensis* on Idaho fescue at the forest camp near Targhee Pass, above mentioned. The spores in the collection on *Festuca* (A.S. *20,638*) were non-septate, proportionately much longer than broad, 29–69 × 4.5–6.5 μ. This material had brown to black lesions but lacked the charred stromatic mycelium of the *Septogloeum*. The spores of A.S. *20,638* were wider than in the type of *P. idahoensis* but closely resembled them in outline (**8**, Fig. 1, E). The Targhee Pass collection was made in the type area which was given as Trude, Idaho (**8**). While we were not able to find the fungus at Trude, it was brought out in conversation with Fischer that the material collected on July 28, 1945, was labelled Trude but was collected in territory stretching from there to Targhee, Mont., the region being somewhat thinly populated. Therefore, the type area is probably closer to Targhee Pass, and A.S. *20,638* is probably a topotype. In this line, it is interesting to note that another topotype (A.S. *20,643*) of *P. idahoensis* collected Aug. 11, 1950, shows both macrospores of *Phleospora idahoensis* and microspores of the black-stem fungus, *Phoma* sp., in the same pycnidium. *Phoma* sp. has been somewhat of a mystery (**10, 12, 13**), but the evidence from the Idaho specimen now indicates that it is the microspore stage of *P. idahoensis*. Apparently the microspore form is the commonest stage of this species. When one compares the symptoms, the relationship of the two stages appears fairly obvious. When seen alone, the

microspore stage is confusing. It occurs on *Festuca elatior* in Alaska and Idaho, on *F. idahoensis* in Idaho and Mont., on *F. rubra* in Alaska, and on *F. occidentalis* in Idaho and Mont.

HELMINTHOSPORIUM BUCHLOËS Lefebvre and A. G. Johnson was prevalent on *Buchloë dactyloides* (Nutt.) Englm. near Colfax, N. Mex., and also caused scattered spots on *Bouteloua gracilis* (H.B.K.) Lag. five miles south of Colorado Springs, Colo. The material on both hosts appeared identical with that described by Lefebvre and Johnson from great plains material (**6**) on *Buchloë* alone. It was common on the crowns of species of grama in the north (**12**).

HELMINTHOSPORIUM VAGANS Drechsl. (**1**) was found on *Poa secunda* Presl near Wenatchee, Wash., on March 23, 1950 (A.S. *20,550*). Typical purplish-black, later brown or stramineous spots were common on the very young foliage. The injury was heavy enough in shaded areas to severely reduce the number of leaves. The lesions frequently extended across the narrow young leaves causing abscission or death. I have seen this disease many times on early-season desert and native grassland *Poa* spp. but have seldom collected it (Oregon and Idaho) and the fungus rarely sporulates on these hosts. The 1950 material sporulated sparingly. The fungus soon disappears in the desert and semi-desert areas after warm weather comes. In a trip across the state from Wenatchee, Wash., to Pullman, Wash., in early spring of 1950, the fungus was found in five out of six places examined along the way. In 1950, at least, the fungus was almost omnipresent in early spring on the young growth.

MASTIGOSPORIUM RUBRICOSUM (Dearn. and Barth.) Nannft. caused a brown spotting on living leaves of *Deschampsia atropurpurea* (Wahl.) Scheele at Lake Eileen, Chelan Co., Wash., Sept. 4, 1950 (A.S. *20,627*). This is a new host-genus for *M. rubricosum* in North America. Jorstad (**5**) described *M. deschampsiae* with muticate, 4- to 7-septate spores 40–68 × 15.5–20 μ. The material from the Cascade Mts. has 3-septate, muticate spores 40–50 × 13–15 μ.

OVULARIA PUSILLA (Ung.) Sacc. and D. Sacc. causes black or deep chocolate-brown streaks on leaves of *Melica bulbosa* Geyer near Targhee, Mont. (A.S. *20,631*). The streaks are 0.5–5.0 ×

0.2–0.4 mm. diam. Under the low-power binocular (× 45), two parallel rows of hyaline clusters of conidiophores occur down the margins of the minute lesions. The few hyaline elliptical to ovate spores are 10–17.5 × 8.5–9.8 μ. The fungus is apparently *O. pusilla*. I have no report of this fungus on *Melica* in the western area.

O. pusilla causes a relatively conspicuous buff spot on leaves of *Trisetum spicatum* (L.) Richt. at Togwotee Pass, Wyo. The spots enlarge more or less radially and extend across the width of the leaf, then continue to develop to about 4 × 4–8 mm. diam. The centers are sometimes paler than the main body of the lesions. This, plus a yellow margin, gives them a false target-spotting effect. The material was common in 1948 and even more so in 1950 (A.S. *20,641*) in mountain meadows at this place. The contrast in symptoms with that on *Melica* is great, but the fungus is apparently the same on both hosts.

RHYNCHOSPORIUM ORTHOSPORUM Caldwell caused a gray, later isabelline streak and scald on young leaves of *Alopecurus pratensis* L. (A.S. *20,556; 20,557*) in the Soil Conservation Nursery, Pullman, Wash. The material collected on March 29, 1950, by J. Park and myself was abundant. This collection compared with that seen in earlier years at Corvallis, Oregon, on *A. pratensis* where it was prevalent in late winter along roadsides and in pastures.

SCOLECOTRICHUM GRAMINIS Fckl. was found on *Stipa pinetorum* Jones about 18 miles west of Ely, Nev., on July 31, 1950 (A.S. *20,629*). This appears to be the first report of a parasitic species of fungus on this host.

HENDERSONIA sp. and the filiform spermatia of apparently a species of *Phyllachora* occur in a tar spot on *Muhlenbergia torreyi* (Kunth) Hitchc. about 15 miles north of Colfax, N. Mex. (A.S. *20,649*). The black stromata are linear, about 0.5 × 0.1 mm. The most prevalent fungus was a species of *Hendersonia* with light brown tri-septate, fusiform spores, 12–21 × 3.6–5.0 μ. The pycnidia were black, brittle, globose, clustered, and had a small ostiolar pore. They appeared to be parasitic on the tar spot. *Hendersonia* or *Hendersonula* spp. have been reported as part of the life cycle of *Phyllachora*. *Hendersonula aristidae* (Schw.) Ellis is sometimes listed as a synonym of *Dothidella aristidae*. If this fungus

on the tar spot is a hyperparasite, as appears likely, it belongs in *Hendersonia*. If it is part of the life cycle of *Phyllachora*, and is in a stroma of its own tissue, it would be classed as *Hendersonula*. It should be mentioned that *Phyllachora coloradensis* Orton has conidia associated with the stroma which are 4-celled, fusiform, hyaline, 15–20 × 5.5–7.0 μ. Except for the hyaline color and the greater width, these could be the same as material from Colfax, N. Mex. Along this line we have seen scanty material on *Muhlenbergia* from Texas labelled *Hendersonia* in the Mycological collections, U.S.D.A., Beltsville, Md. It proved to have *Phyllachora* sp. on it with spores somewhat larger than those of *P. coloradensis* and close to *P. texensis*. It also contained spermatia. Since someone must have seen *Hendersonia* in some of this Texas material, it is likely that it represents a case comparable to that from New Mexico.

ERYSIPHE GRAMINIS DC. was found on *Puccinellia nuttalliana* (Schult.) Hitchc. west of Eureka, Nev. (A.S. *20,633*) and near Sinclair, Wyo. Mildew has been found on *P. distans* (L.) Parl. at Pullman, Wash., and that is our only previous report of *Erysiphe* on this genus.

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STUDIES IN THE GENUS PLEOSPORA. IV [1]

LEWIS E. WEHMEYER

(WITH 20 FIGURES)

In a previous paper (**6**) the development of the *vulgaris* series of this genus, through the 5-septate stage, and of the *herbarum* series through the 7-septate stage was followed. In a second paper (**7**), concerned with those species having setose perithecia, several species with more than seven septa were included. The present paper has to do with a somewhat more complicated group of the *herbarum* series, in which the perithecia are glabrous or merely tomentose and in which the spores have developed beyond the 7-septate condition by the insertion of additional transverse septa.

Collections are referred to by number, which in turn refers to the list of collections, with detailed data, at the end of the paper. TABLE I gives data as to microscopical measurements and the presence of tomentum or setae on the perithecia, for each collection, also by number.

It is necessary at this point to follow carefully the consecutive insertion of the septa. In a previous paper (**6**, FIG. 1) a figure was given and a nomenclature for these septa was proposed. A 3-septate spore gives rise to a 5-septate spore (in the *herbarum* series) by the formation of secondary septa of the *vulgaris* type in the two central cells, and from such a spore the 7-septate spore is derived by the formation of secondary transverse and vertical septa in each of the end cells. These secondary septa in the end cells commonly take the form of a "Y."

The insertion of additional septa in the 7-septate spore, such as found in *P. herbarum* or *P. Armeriae*, first appears as tertiary septa in the ultimate or penultimate cell of the lower end of the spore. If the transverse and vertical septa are normally formed this results in four or five septa below, and three above, the central primary septum, giving an 8- or 9-septate spore (FIGS. 3, 4). If, on the

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other hand, the secondary septation in the 7-septate stage has resulted in a Y-shaped septum in the lower end cell, the tertiary septa are laid down at various levels and various angles to the stem of this Y, which represents the vertical septum. In such a case the varying number of complete or incomplete transverse septa form an irregular oblique septation in the end of the spore (FIG. 1) and the actual number of cross septa are difficult to determine.

Because these additional tertiary septa are always inserted first in the lower portion of the spore, the asymmetry of the spore

TABLE I

Coll. No.	Host	Spores	Asci	Perithecia
		Pleospora coloradensis E. & E.		
295	Polemonium	30–40×13–16	100–125×25–40	200–250,T,s
294	Senecio	30–46×18–19	115–170×32–38	250–350,T
293	Achillea	35–41×16–18	125–140×33–41	250–300,T
292	Rydbergia	35–41×14–17	95–140×35–39	200–300,T
296	Hedysarum	37–42×16–18	90–133×30–35	300–400,T,s
297	Linum	37–44×14–19	100–140×30–42	200–250,t
		Pleospora njegusensis Bub		
298	Balsamorrhiza	33–44×15–19	115–150×44–50	250–250
257a	Achillea	33–46×12–17	85–100×30–35	250–300
299	Zygadenus	34–44×13–17	105–125×32–35	200–300,t
300	Valeriana	37–47×14–18	115–150×39–42	
542	Balsamorrhiza	37–48×18–23	160–175×35–40	300–400
302	Lupinus	39–51×16–20	135–145×40–45	150–250,T
303	Linum	41–46×16–20		450,T
304	Gillia	41–54×21–23	150–180×40–55	250–400
305	Agastache	42–48×16–18	135–150×40–45	300–400
306	Clematis	42–50×16–19	105–135×43–47	250
308	Gillia	43–58×20–25	160–175×50–53	300–400
307	Pedicularis	43–53(57)×17–18	175–180×30–35	300–400,T,s
309	Hedysarum	44–50(53)×15–19	140–150×47–52	200–300,t
310	Hedysarum	46–53(57)×17–18	175–180×30–35	300–400,T,s
		Pleospora obliqua sp. nov.		
354	Grass	24.5–28.5(32)×9–10	124–150×25–30	220–250
		Pleospora laxa Ell. & Holw.		
252	Carex	38–53×14–19.5	140–175×45–49	150–250
528	Potentilla	52–58×23–25	128–160×50–60	200–250
		Pleospora montana Wehm		
317	Lupinus	41–53×17.5–21	175–210×57–60	300–350,T
316	Lupinus	41–51(56)×16–21.5	125–142×50–55	150–300,T
320	Lupinus	50–62×14–15		300–400,T
		Pleospora alpestris E. & E.		
314	Anthyllis	33–42(48)×12.5–16	90–125×27–30	300–400
315	Trollius	37–53(55)×16–21	140–160×39–48	200–250
318	Lupinus	43–57×17–21	125–135×40–45	200–300

TABLE I (cont.)

Coll. No.	Host	Spores	Asci	Perithecia
		Pleospora asymmetrica sp. nov.		
537	Agrostis	43–67×16–26	200–250×50–60	200–300
552	Poa	49–61×19–24.5	160–175×40–45	200–300,s
529	Festuca	55–81×21–30	170–180×53	250–350
531	Lupinus	56.5–72×19–25	175–200×40–50	300–500
551	Grass	60–82×26–35	200–210×70	300–400
538	Muhlenbergia	63–70×26–30	170–200×55–70	300–350
		Pleospora pulchra Kirschst.		
311	Typha	35–44×14–16	140–145×30–35	200
		Pleospora longispora Speg.		
255	Hierochloa	39–50×12.5–17	110–125×35	200–300
		Pleospora amplispora E. & E.		
319	Lupinus	60–70×23–26	130–150×53–78	400–500
		Pleospora multiseptata Starb.		
291	Artemisia	43–53×12.5–18	140–160×43	100–300
		Pleospora rainierensis sp. nov.		
530	Muhlenbergia	(44)64–77×(20)23–30	195–230×53–60	250–350
527	Composite	58–68×32–39	200–350×20–25	

increases with the number of additional septa and the lower portion (below the primary central septum as the spore lies in the ascus) becomes longer, narrower, more strongly tapered, and has more septa than the upper portion. In general, the spores also increase in size (see TABLE I) and in the number of vertical septa in face view, with the increase of transverse walls.

There are included in this account some four species which show the 8- or 9-septate condition of the spore. As might be expected, the two types of septation mentioned (and also intermediate ones) are not limited to single species or even collections. One and the same collection may show 7-septate spores, irregularly septate spores, or spores with eight or nine regular septa. For this reason there is an overlapping of characters in these species and more collections are needed to verify the distinctness of some of them. The few collections seen, however, show certain correlated differences which make it seem best to keep them separate.

The series of species with dark brown or red-brown spores which seems to be characteristic of high altitudes and has been mentioned in previous papers (**5**, **6**, **7**) continues here and is represented by

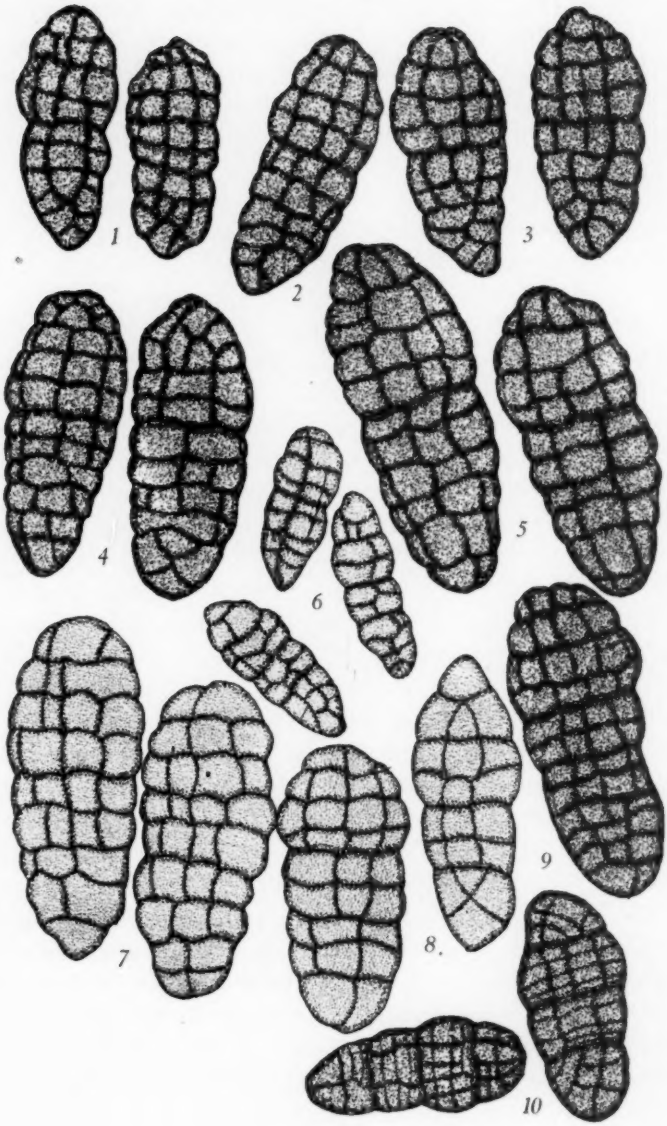
P. coloradensis E. & E. and *P. njegusensis* Bub. The former species includes those collections in which the spores are predominantly irregular in their septation in the lower end cells and *P. njegusensis* those in which the spores are regularly 8- or 9-septate. Collections with similar spores but with setose perithecia are placed in *P. comata* Niessl (**7**).

P. obliqua sp. nov. and *P. laxa* Ell. and Holw. have spores with a similar septation but light to dark yellow-brown in color. The spores of *P. laxa* are similar in form and size to those of *P. njegusensis,* but those of *P. obliqua* are definitely smaller.

In many collections it is found that the insertion of the tertiary septa may take place in one or all of the cells in the lower portion of the spore and also occasionally in some of the cells of the upper portion. In *P. montana* Wehm. this insertion is quite regular and results in seven septa below the central septum, and eleven septa in most of the spores. *P. alpestris* has dark red-brown spores as does *P. montana* but the insertion of the tertiary septa is tardy and irregular and the septa themselves are often indefinite or thin, whereas the primary and secondary septa are well developed. These spores are from 7–13-septate. Both these species are found at high altitudes and are darkly pigmented.

P. pulchra Karst., *P. longispora* Speg. and *P. asymmetrica* sp. nov. all have yellow-brown spores. The spores of both *P. pulchra* and *P. longispora* are rather long and narrow with faint and irregular tertiary septa, but the spores of *P. pulchra* are smaller. *P. asymmetrica* has broader spores with the form of *P. montana,* the variable septation of *P. alpestris,* but a yellow-brown color and larger spores.

The insertion of quaternary septa is exhibited in the species *P. amplispora* E. & E. and *P. multiseptata* Starb., the former with red-brown and the latter with yellow-brown spores. It is difficult here to determine the sequence of septation. In the mature spores of *P. amplispora* (FIG. 17), for instance, there are usually two septa in the lower portion which are thicker and more prominent (this is also true of the spores of *P. alpestris* and *P. abbreviata*). Whether the upper of these septa is secondary and the lower primary or vice versa, is difficult to determine.

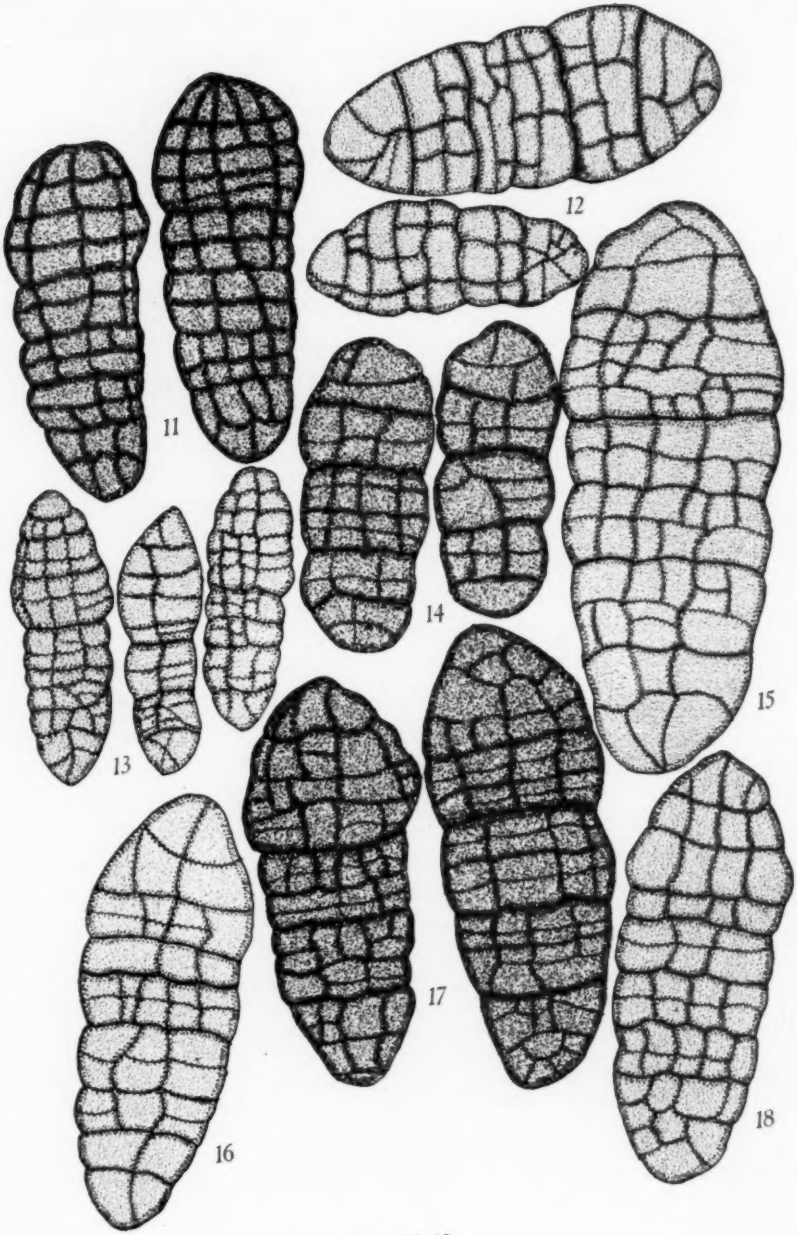


FIGS. 1–10.

If one examines other species in this series, it will be seen that the secondary and tertiary septa arise first and are most regular and distinct between the central and lower primary septa (FIG. 14) where they appear as three somewhat fainter walls. A tertiary wall next appears between the lower primary and lower secondary septum (i.e., as in *P. montana,* FIG. 11). Finally, the tertiary septa in the end cell, below the lower secondary septum, are likely to be irregular and at varying angles. Applying these arguments to the spores (FIG. 17) of *P. amplispora,* the lower heavy wall is secondary and the upper one is primary. Consequently there are no quaternary walls above the lower primary wall, the three septa here representing a secondary and two tertiary walls. Between the lower primary and secondary septa, however, the three walls represent a tertiary and two quaternary septa. The irregular septa below the lower secondary septum represent a tertiary and often quaternary septa. This arrangement also applies to *P. pulchra* and *P. longispora,* but in these species the tertiary and quaternary walls are likely to be faint or lacking.

In all these species it should be noted that most of the vertical walls pass continuously through two cells, so that there are three or four pairs of cell layers lying between the central primary and the lower secondary walls. This is probably due to the fact that in the *vulgaris*-type of septation of the central cells the vertical wall is often laid down first and the transverse walls afterwards. In *P. rainierensis* there is a curious modification of this pattern. It will be noted that the spores of this species (FIGS. 16, 18) have about the same type of septation as *P. montana* but that there are eight (or nine) septa in the lower portion rather than seven (or eight), and that there is a layer of cells just beneath the main con-

FIGS. 1–10. 1. Spores from the type collection (*295*) of *Pleospora coloradensis* E. & E. 2. Spore from a collection (*297*) of *Pleospora coloradensis* E. & E. 3. Spores from a collection (*292*) of *Pleospora coloradensis* E. & E. 4. Spores from a collection (*302*) of *Pleospora njegusensis* Bub. 5. Spores from a collection (*308*) of *Pleospora njegusensis* Bub. 6. Spores from the type collection (*354*) of *Pleospora obliqua* sp. nov. 7. Spores from a collection (*528*) of *Pleospora laxa* Ell. & Holw. 8. Spores from the type collection (*252*) of *Pleospora laxa* Ell. & Holw. 9. Spore from a collection (*317*) of *Pleospora montana* Wehm. 10. Spores from a collection (*314*) of *Pleospora alpestris* E. & E.



FIGS. 11–18.

striction of the spore which shows a vertical septation which is not in juxtaposition with the two layers below it. Apparently, the central primary septum is not at the main constriction of the spore but is the septum below this constriction. Otherwise the lower portion of the spore shows the usual three pairs of cell layers plus the irregular septation in the lower end.

PLEOSPORA COLORADENSIS E. and E. Proc. Acad. Nat. Sci. Phila **1895**: 422. FIGS. 1–3

Perithecia 200–400 μ in diameter, scattered, depressed-globose, usually somewhat tomentose; walls 20–50 μ thick, of dark colored parenchyma; hyphal tomentum usually sinuous, creeping, but sometimes rather stiff, hair-like.

Asci broad-clavate, apical wall thickened, base claw-like, 90–140 × 20–42 μ.

Spores biseriate, oblong-ellipsoid, sometimes 7-, mostly 8- or 9-septate, dark yellow-brown to dark red-brown, mostly asymmetric, broader and shorter above, narrower and longer below, constricted at central septum, not or slightly constricted at the other septa, ends broadly rounded, lower end of spore commonly with irregular oblique septation, or with *vulgaris* type tertiary septation in the penultimate cell, 30–44(46) × 14–19 μ.

Collections: *292, 293, 294, 295* (Type), *296, 297:* On herbaceous stems, Wyoming and Colorado.

This species was previously referred to by the author (**4**) as *P. stenospora.* The type of *P. coloradensis* E. and E. (*295*) has many 7-septate spores, but just as many with the irregular oblique septation in the lower end and is typical of this group of collections found at rather high elevations in the Rocky Mountain region. Not having seen the type of *P. stenospora,* this binomial is used as being more definite for this species group. The spores are nearly always reddish-brown in color. Some collections will show 7-

FIGS. 11–18. 11. Spores from the type collection (*316*) of *Pleospora montana* Wehm. 12. Spores from the type collection (*537*) of *Pleospora asymmetrica* sp. nov. 13. Spores from the type collection (*311*) of *Pleospora pulchra* Kirschst. 14. Spores from a collection (*318*) of *Pleospora alpestris* E. & E. 15. Spores from a collection (*529*) of *Pleospora asymmetrica* sp. nov. 16. Spore from the type collection (*530*) of *Pleospora rainierensis* sp. nov. 17. Spores from the type collection (*319*) of *Pleospora amplispora* E. & E. 18. Spore from a collection (*527*) of *Pleospora rainierensis* sp. nov.

septate spores of the *P. herbarum* var. *occidentalis* type, or 9-septate ones of the *P. njegusensis* type, for there is a continuous overlapping series of collections showing this change in septation. Any collection with some or most of the spores showing the oblique septation in the lower end is placed here.

In collections such as No. *296*, in which the tomentum sometimes forms stiff hairs which may penetrate the epidermis, this species grades into *Pleospora comata* Niessl.

PLEOSPORA NJEGUSENSIS Bub. Botan. Kozlem. **1915**: 60. FIGS. 4–5

Perithecia (150–)200–400 μ in diameter, globose or depressed-globose, variously scattered, sometimes smooth, but often tomentose with sinuous, creeping or stiff, somewhat spine-like hyphae; wall rather thick, 20–50 μ, composed of coarse dark-colored parenchyma.

Asci broad-clavate, thick-walled, with a claw-like base, 105–220 × 30–55 μ.

Spores biseriate, oblong-ellipsoid, dark yellow-brown to very dark red-brown, 8–10-septate, mostly straight, rarely inequilateral, mostly asymmetric with a broader, shorter, upper and a longer, narrower, lower portion, constricted at the central septum and sometimes at the other septa, ends broadly rounded, usually with a *vulgaris* type septation in the lower penultimate cell, and often with a tertiary septum in the lower end cell; upper half of the spore usually 3-septate, sometimes 4-septate, vertical septa one to three between each two transverse septa, 33–58(–62) × 13–25 μ.

Collections: *257a, 298, 299, 300, 302, 303, 304, 305, 306, 307, 308, 309, 310, 542:* On herbaceous stems and leaves, from Wyoming, Colorado, and Washington.

This name is used in the same sense as previously (**4**) for a second group of collections from fairly high elevations in the Rocky Mountain regions, which differ from *P. coloradensis* in the more regular insertion of the *vulgaris* tertiary septation in the lower penultimate cell, an occasional fourth septum in the upper half of the spore and a somewhat larger spore range. Collection No. *257a* represents one of the many species of *Pleospora* occurring on the type of *P. megalotheca* Tracy and Earle, but it is not apparently the one described, which is given as having eleven to thirteen septa.

Here, again, such collections as Nos. *302* and *307,* with a stiff tomentum, grade toward *Pleospora comata,* with setose perithecia.

Pleospora obliqua sp. nov. FIG. 6

Perithecia 200–250 μ diametro, depresse globosa vel conica, erumpentia ex maculis rufo-purpureis, pariete 10–40 μ crasso, sursum crasso, deorsum tenui. Asci 125–150 μ longi, 23–30 μ crassi, clavati, crasse membranosi, basi unguiculiformes. Sporae 24.5–32 μ longae, 8–9.5 μ crassae, biseriatae, fusiformes vel oblonge ellipsoidales, plurimum rectae et symmetricae, ad septa constrictae, angustatae vel rotundatae, primum 7-septatae, saepe cum septo tertiario intra cellulam ultimam vel penultimam; parietibus saepe obliquis intra cellulam ultimam.

Specimen typicum (n. *354*) vide infra in enumeratione locorum. In caulibus *Agrostidis* vel *Airiae,* in silvo prope Königstein.

Perithecia 200–250 μ in diameter, depressed-globose, or conic with a flattened base and a stout conic ostiole erumpent through the epidermis, widely scattered on purplish-red spots; wall 10–40 μ, thicker above, pale and poorly developed below.

Asci clavate with a thickened wall and a claw-like base, 125–150 × 25–30 μ.

Spores biseriate, fusoid- to oblong-ellipsoid, yellow-brown, 7–9-septate, mostly straight and symmetric, constricted at the central septum and slightly so at the other septa, somewhat tapered but bluntly rounded at the ends, basically 7-septate but often with a tertiary septum in the penultimate cell or also in the end cell of the lower portion of the spore; walls often at oblique angles, at either end of the spore, 24.5–32 × 8–9.5 μ.

Collection: *354* (Type): On grass, from Saxony.

This collection was first labelled *P. heterospora* and later *P. punctiformis,* and is a confusing one which might be confused with such species as *P. Heleocharidis, P. rubicunda* and *P. laxa* or *P. coloradensis.* It differs from *P. Heleocharidis* in the more rounded ends of the spores and the different sequence of septation. In this species the 7-septate spore becomes 8-septate by the insertion of *vulgaris* type tertiary septa in the penultimate cell of the lower end and 9-septate by a tertiary septum in the end cell, whereas in *P. punctiformis* secondary and tertiary septa are laid down in both end cells of a 5-septate spore, to make it 9-septate. Furthermore, this species has vertical septa in most of the end cells, whereas those of the *vulgaris* series do not. This species differs from *P. rubicunda* in the straighter, narrower spores with vertically septate end

cells, and from *P. laxa* in the smaller, narrower spores and from *P. coloradensis* in the yellow-brown color.

PLEOSPORA LAXA Ell. & Holw. Jour. Myc. **5**: 66, 1889. FIGS. 7–8

Perithecia 150–350 μ in diameter, somewhat flattened spheric, widely but evenly scattered, erumpent through the epidermis as small papillate ostioles appearing as minute black dots.

Asci broad clavate, thick-walled, base claw-like, 140–175 × 45–60 μ.

Spores biseriate, yellow-brown to dark yellow-brown, 7- to 9-septate, broad fusoid-ellipsoid, straight or very slightly inequilateral, asymmetric, broad rounded above, narrower and tapered below, ends abruptly pointed or bluntly rounded, strongly constricted at central septum, not at others, secondary and vertical septa often faint and irregular, 35–58 × 15–25 μ.

Collection: *252* (Type), *528:* On *Carex* and *Potentilla,* from Montana and Washington.

This species has spores similar to those of *P. coloradensis,* but yellow-brown in color, they may be 7-septate, or have a tertiary septum in the penultimate or sometimes the end cell of the lower end. The secondary, tertiary and vertical septa are often thin, faint, and irregularly placed at various angles, a characteristic common to this group of species on aquatic monocotyledons.

Ellis says that the spores tend to fall apart in two halves because of the strong central constriction and that this species differs from *P. islandica* Johans. only in the blunt ends of the spores. In the type, no spores were seen to be constricted in halves, and most of them had pointed, although abruptly pointed ends. Berlese (**1**, *Pl. 41, fig. 1*) figures only the 7-septate *herbarum* type of spore for this species.

Collection No. *528* is placed here with some misgiving, for the spores are quite a bit larger (52–58 × 23–25 μ) than the type. It has the same septation, however, and is yellow-brown. These spores are similar to those of *P. asymmetrica* or *P. ranierensis,* before the tertiary septa develop.

PLEOSPORA MONTANA Wehm. Lloydia **9**: 224. 1946. FIGS. 9, 11

The description of this species has been given previously (**4**) and need not be repeated, but certain modifications should be made as follows:

Collections: *316, 317, 320:* On *Lupinus,* from Colorado and Wyoming.

Collection *318,* previously placed under this species, actually shows the irregular septation of *P. alpestris* and is placed under that species. Clement's collection (*320*), labelled *Pyrenophora gigantis,* is this species. The perithecia are tomentose but not setose. The spores of this species have a complete and distinct set of primary, secondary and tertiary septa, in the lower portion, giving seven septa in the lower end. In most cases, only the three primary and secondary septa are found above the central primary septum, but occasionally tertiary septa are found in the two secondary cells above this septum making five in the upper half of the spore. This species, again, has been seen only from middle elevations in the Rocky Mts.

PLEOSPORA ALPESTRIS E. & E. Proc. Acad. Nat. Sci. Phila. **1894**: 336. FIGS. 10, 14

Perithecia 200–250 μ in diameter, somewhat flattened-spheric, rather widely scattered, erumpent as a minute ostiole; wall 10–20 μ thick, of rather large, dark-brown parenchyma cells, sometimes somewhat tomentose.

Asci broad-clavate, thick-walled, base claw-like, 140–160 $\times$39–48 μ, often 4- or 6-spored.

Spores biseriate, oblong-ellipsoid, dark yellow-brown to dark red-brown, septation variable with 7–13 septa, straight or slightly inequilateral, asymmetric, broader and shorter above, narrower and longer below, constricted more or less at the central primary septum, two to three vertical walls in face view; young spores with seven or eight primary and secondary septa, older spores with tertiary septa laid down as in *P. montana,* but in an irregular fashion and appearing thinner and fainter than the earlier septa, 33–57 $\times$ 12.5–21 μ.

Collections: *314, 315* (Type), *318:* On herbaceous stems, Wyoming, Colorado and the Alps.

This species differs from *P. montana* only in the irregular septation of the spores. The young spores are mostly 7–8-septate, with rather distinct septa. These septa are followed by tertiary septa in all of the cells of the lower part of the spore, but these septa are thin, often indistinct, or incomplete, resulting in a very irregular

and variable septation. This is apparently not a mere difference in maturity, for even the fully formed and colored spores show this irregular arrangement. Collection No. *314* of *P. multiseptata,* on *Anthyllis,* agrees very well with Niessl's description (**3**) of *P. Anthyllidis* Awd. & Niessl, but this latter species might also be the same as *P. montana,* and type material is needed to determine the proper use of these binomials. Berlese's figure (**1**, *Pl. 41, fig. 2*) shows the primary septa as thicker and more prominent, as given here for *P. alpestris. P. abbreviata* has this same type of spore, but they are found in setose perithecia.

Pleospora asymmetrica sp. nov. FIGS. 12, 15

Perithecia 250–500 μ diametro, globosa vel depresse globosa, dispersa, erumpentia; ostiolo papilliformi; pariete 30–70 μ crasso, atro, parenchymatoso, basi sparse tomentoso. Asci clavati, 170–250(–350) μ longi, (20–)40–60 μ crassi, crasse membranacei; basi unguiculiformes. Sporae biseriatae, 43–81 μ longae, 16–30 μ crassae, cylindrico-ellipsoidales, luteo-brunneae vel brunneae, primum 8- vel 9-septatae, dein 12- vel 14-septatae, interpolatione septorum transversorum in cellulis quibusquibus vel omnibus, ad septum medium constrictae, rectae, transverse asymmetricae, apicem versus latiores brevioresque, utroque termino late rotundatae.

Specimen typicum leg. Wehmeyer (n. *537* v. infra in enumeratione locorum), in caulibus *Agrostidis,* ex monte "Rainier," in republica Washingtonensi.

Perithecia 250–500 μ in diameter, globose to depressed, scattered, erumpent as papillate ostioles; walls thick stromatic, 30–70 μ, of black parenchyma, smooth or very slightly tomentose at base.

Asci clavate, becoming elongate, apical wall thickened, base clawlike, 170–250(–350) × (20–)40–60 μ.

Spores biseriate, or uniseriate when being discharged, cylindric-ellipsoid, yellow-brown to dark yellow-brown, 8–9-septate when immature, but soon becoming 12–14-septate by insertion of tertiary transverse septa in any or all cells, constricted at central primary septum, straight, strongly asymmetric, broader and shorter above, ends broadly rounded or abruptly tapered, two to four vertical septa, oblique walls in lower end cells not common, 43–81 × 16–30 μ.

Collections: *529, 531, 537* (Type), *538:* On herbaceous stems and grasses, from Washington.

These collections are very similar to *P. montana* in the form and septation of the spores but the type of that species has dark red-brown almost opaque spores, with much more definite regular septa, and more broadly rounded ends. In all of the above collec-

tions, the spore is obviously derived from a 7-septate one, and in immature spores (FIG. 12), as in collections *537, 529* and *538,* the original seven septa are obvious as well-developed cross-walls, whereas the later transverse septa, which develop in all of the cells below the primary central septum, and in some of those above it, are thin, faint and often collapsed. In mature spores they may all be definite. This results in seven (or more) septa below and three to seven above the primary central septum.

In *P. amplispora,* which has spores about the same size and shape, tertiary septa often occur in an irregular manner, in some cells, and there are often additional oblique septa in the lower end. In *P. alpestris,* the spores are darker red-brown and somewhat smaller.

PLEOSPORA PULCHRA Kirschst. Verh. bot. Ver. Brandenburg **48**: 57. 1906. FIG. 13

Perithecia 200 μ in diameter, scattered, on reddish spots (?).

Asci stout-clavate, thick-walled, with a claw-like base, 140–145 × 30–35 μ.

Spores irregularly biseriate, fusoid- to oblong-ellipsoid, dark yellow-brown; septation variable, primarily 8–9-septate, with four or five septa in the lower portion, but with the formation of tertiary septa in any of these cells in an irregular fashion, resulting in 10–15 transverse septa, vertical septa two or three in face view, also in end cells; spores straight or slightly inequilateral, asymmetric to almost symmetric, tapered toward the ends, but bluntly rounded, 35–39(–44) × 12.5–14(–16) μ.

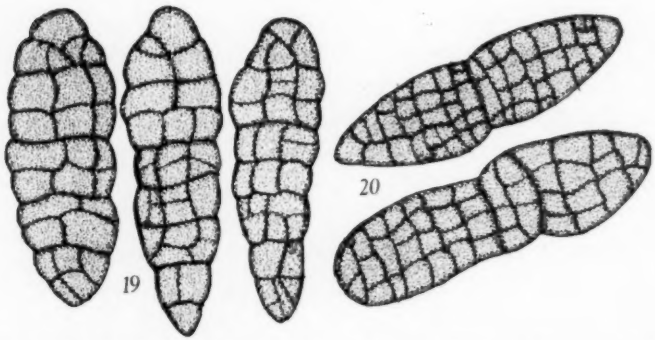
Collection: *311* (Type): On *Typha,* from Germany.

The description of *P. pulchra* says the perithecia occur on reddish spots. The portion of the type examined yielded only one small red spot with a few perithecia upon it. The spores are narrow fusoid and primarily 7–9-septate as in *P. obliqua,* but faint and irregular septa are laid down in the cells of such spores as they mature. It seems to be derived from that species, but has larger spores with additional septa. The following species, *P. longispora,* has this same sort of septation and is very similar, but the spores are paler yellow-brown, and more asymmetric.

PLEOSPORA LOGISPORA Speg. Fung. Fueg., Bol. Acad. Nac. Cienc. Cordoba **11**: 95. 1887. FIG. 19

Perithecia 200–300 μ, depressed-spheric, widely scattered, immersed, forming indefinite spots.

Asci broad-clavate, with a greatly thickened wall and a claw-like base, 110–125 × 35 μ.



FIGS. 19–20. 19. Spores from the type collection (*255*) of *Pleospora longispora* Speg. 20. Spores from the type collection (*291*) of *Pleospora multiseptata* Starb.

Spores overlapping biseriate, fusoid- to clavate-ellipsoid, pale yellow-brown, irregularly 7–9- or many-septate, mostly straight or slightly curved, asymmetric, broad and rounded above, narrow and tapered below the primary central septum, constricted at the primary central septum and slightly so at the others, primarily two or three septa above and four or five below the primary central septum, but later with faint septa inserted irregularly in any or all of these cells, resulting in a many-septate spore. Vertical septa two or three in face view, also in end cells. Spores 39–49 × 14–16 μ.

Collection: *255* (Type): On *Hierochloa*, from Tierra del Fuego.

This collection is very similar to the preceding in its type of septation, with eight or nine prominent septa formed and a variable number of fainter irregular ones laid down later. The septa in the ends of the cell are, again, often at oblique angles. These spores differ from those of *P. pulchra* in their somewhat larger size, paler color and greater asymmetry of form.

PLEOSPORA AMPLISPORA E. & E. Bull. Wash. Univ. Lab. Nat. Hist. **1884**: 41. FIG. 17

Perithecia 400–500 × 250–350 μ, globose or somewhat flattened, soon erumpent-superficial, scattered, ostiole short, papillate; wall stromatic, 40–50 μ thick, composed of flattened, dark-colored parenchyma.

Asci broad-clavate, very thick-walled, base claw-like, 130–300 × 53–78 μ, imbedded in a fine-celled, interthecial stroma.

Spores biseriate to triseriate, oblong-ellipsoid, dark red-brown to almost opaque, 13–15- or more -septate, straight, asymmetric, upper portion broad, short and rounded, lower portion longer, narrower and slightly tapered, constricted at the central primary septum, ends broadly rounded, three to five septa above and eight to twelve below the central primary septum, two to five vertical septa in face view, 60–70 × 23–26 μ.

Collection: *319* (Type): On *Lupinus,* from Washington.

The type collection shows spores (FIG. 17) which are like those of *P. montana* but larger and with additional "quaternary" septa in the two central secondary cells and often some irregular "oblique" septa in the lower end cell. These last septa are often tardily and incompletely formed, but are usually obvious. It is the culmination of this series with dark red-brown spores found in the Rocky Mountain region.

Ellis (**2**, p. 342) gives his species as a synonym of *P. gigaspora* Karst. This may well be true, but one should see type material to be certain of this synonymy.

PLEOSPORA MULTISEPTATA Starb. Bot. Notiz. 207. FIG. 20

Perithecia 100–300 μ in diameter, globose then somewhat flattened, immersed, scattered, on purplish-red areas, erumpent as short ostioles.

Asci clavate, rather thick-walled, with a claw-like base, 140–160 × 43 μ, surrounded by numerous filiform interthecial elements.

Spores overlapping biseriate, long fusoid-ellipsoid, pale yellow-brown, 15–17-septate, surrounded by a mucous sheath, mostly straight, asymmetric, constricted somewhat above the middle, tapered toward the ends, cut up into numerous cubical cells by transverse and vertical septa, six to seven septa above and eight or nine below the central constriction, vertical septa two to five, 43–55 × 12.5–18 μ.

Collection: *291* (Type): On *Artemisia*, from Sweden.

The type material of this species is immature. It shows the long, fusoid, pale yellow, many septate spores described, but the septa are difficult to make out in the young spores. This may be looked upon as the culmination of the type of septation found in *P. pulchra* and *P. longispora*.

Berlese (**1**, *Pl. 42*) figures these spores, but with somewhat fewer septa. More and better spore material is needed to make an accurate interpretation of the septation in this species.

Pleospora rainierensis sp. nov. FIGS. 16, 18

Perithecia 250–350 μ diametro, globosa vel depresse globosa, dispersa, superficialia ut maculae atrae. Asci clavati, dein longe cylindrici, 195–350 μ longi, 20–60 μ crassi, crasse membranacei; basi unguiculiformes. Sporae (44–)58–77 μ longae, (19–)23–34 μ crassae, biseriatae vel imbricate uniseriatae, oblonge ellipsoidales, luteo-brunneae, 12- vel 14-septatae, rectae, asymmetricae, superne breves lataeque, utroque termino late rotundatae, ad septum supra primarium centrale constrictae, cum 3–5 septis sursum et 5–8 septis deorsum; septis tertiariis saepe obscuris vel nullis; 2–3 septis verticalibus in aspectu frontali.

Specimen typicum sub numero *530* (v. infra in enumeratione locorum), in caulibus *Muhlenbergiae filiformis*, ex monte "Rainier," in republica Washingtonensi.

Perithecia 250–350 μ in diameter, globose or somewhat flattened, thickly or sparsely scattered, appearing as erumpent blackened spots.

Asci clavate, becoming long-cylindric, apical wall thickened, base claw-like, 195–350 × 20–60 μ.

Spores biseriate, becoming overlapping uniseriate, oblong-ellipsoid, yellow-brown, 12–14-septate, straight, asymmetric, upper portion shorter and broader, ends broadly rounded, constricted, apparently, at the septum above the primary central septum and with three to five septa above and five to eight septa below this constriction, tertiary septa often faint and irregular, two to three vertical septa in face view, (44–)58–77 × (19–)23–34 μ.

Collections: *527, 530* (Type): On *Muhlenbergia* and Compositae, from Washington.

These two collections are separated as a species on the basis of a peculiar anomalous arrangement of the septa. When first seen it was supposed to be an abnormal form of *P. asymmetrica*, but a second collection seemed to argue a distinct difference. Both col-

lections were made within half a mile of each other in Mt. Rainier National Park. The spores have a strong constriction in the upper portion just below the upper swollen part of the spore. The general plan of septa formation is the same as in *P. montana* and *P. asymmetrica* but the primary central septum here appears to be the first septum below the constriction, resulting in eight septa, normally, below the constriction. The first layer of cells below the constriction never shows the *vulgaris*-type of septation, i.e. vertical septa running continuously through two cells, whereas this type of septation is seen in the four pairs of cells below this first layer. There is one primary and one secondary septum above the constriction, and usually a tertiary one in the first cell above the constriction (see FIG. 16, 18).

This same sort of anomalous septation occurs in *Clathrospora Cookei,* where the band of cells above the constriction forms an annular swelling. In collection No. *530,* this *Clathrospora* (*530a*) occurs in association with this species. In this same collection, some of the perithecia of *P. rainierensis* have somewhat smaller spores, 44–51 × 19–20 μ, which do not have the tertiary septa developed and are, therefore, 9-septate, with five septa below the constriction and similar to the spores of *P. laxa.* They seem to be undeveloped spores of this species, but it is situations of this sort which make it desirable to know something of the genetic behavior of these characters.

This same variation in size and septation is found in *P. asymmetrica.*

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255. *Pleospora longispora* Speg., on *Hierochloa antarctica*, Isla de los Estados, Tierra del Fuego, March, 1882 (La Plata Mus. *2164*) (Type).
257. *Pleospora megalotheca* Tracy & Earle, on *Achillea Millefolium*, Bob Creek, La Plata Mt., Colo., 10,500 ft., June 27, 1898 (N.Y.B.G.: Pl. S. Colo. *172*) (Type).
257a. Same data as preceding.
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292. *Pleospora stenospora* Schroet., on *Rydbergia grandiflora*, Skyline Trail, Teton Nat. Park, Wyo., July 24, 1940 (Wehm. Herb. *1175*).
293. *Pleospora stenospora* Schroet., on *Achillea*.
294. *Pleospora stenospora* Schroet., on *Senecio* sp., Skyline Trail, Teton Nat. Park, July 24, 1940 (Wehm. Herb. *1177*).
295. *Pleospora coloradensis* E. & E., on *Polemonium confertum*, Cameron Pass, Colo., July 24, 1894, leg. C. F. Baker (N.Y.B.G.: Ellis coll. No. *273*) (Type).
296. *Pleospora stenospora* Schroet., on *Hedysarum* sp., Skyline Trail, Teton Nat. Park, Wyo., July 24, 1940 (Wehm. Herb. *1173a*).
297. *Pleospora stenospora* Schroet., on *Linum Lewisii*, Skyline Trail, Teton Nat. Park, Wyo., July 24, 1940 (Wehm. Herb. *1167*).
298. *Pleospora njegusensis* Bub., on *Balsamorrhiza sagittata*, Glory Mt., Jackson Wyo., June 20, 1940 (Wehm. Herb. *1025a*).
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302. *Pleospora njegusensis* Bub., on *Lupinus parviflorus*, South of Teton Pass, Jackson, Wyo., July 11, 1940 (Wehm. Herb. *1110*).
303. *Pleospora njegusensis* Bub., on *Linum Lewisii*, South of Teton Pass, Jackson, Wyo., July 11, 1940 (Wehm. Herb. *1134c*).
304. *Pleospora njegusensis* Bub., on *Gillia Watsoni*, Jackson, Wyo., 1940 (Wehm. Herb. *1211*).
305. *Pleospora njegusensis* Bub., on *Agastache urticaefolium*, South of Teton Pass, Jackson, Wyo., July 11, 1940 (Wehm. Herb. *1121c*).
306. *Pleospora njegusensis* Bub., on *Clematis Douglassii*, South of Teton Pass, Jackson, Wyo., July 11, 1940 (Wehm. Herb. *1124a*).
307. *Pleospora njegusensis* Bub., on *Pedicularis Hallii*, Togwotee Pass., Wyo., July 8, 1940 (Wehm. Herb. *1096*).
308. *Pleospora njegusensis* Bub., on *Gillia Watsoni*, South of Teton Pass, Jackson, Wyo., July 11, 1940 (Wehm. Herb. *1118*).
309. *Pleospora njegusensis* Bub., on *Hedysarum uintahensis*, South of Teton Pass, Jackson, Wyo., July 11, 1940 (Wehm. Herb. *1126d*).
310. *Pleospora njegusensis* Bub., on *Hedysarum* sp., Skyline Trail, Teton Nat. Park, Wyo., July 24, 1940 (Wehm. Herb. *1173c*).

311. *Pleospora pulchra* Kirschst., on *Typha latifolia*, Egelpfuhl, Kleinbehnitz, Kr. Werthavelland, Oct. 1, 1904, leg. W. Kirschstein (Riksmuseet: Herb. Kirschstein) (Type).
314. *Pleospora multiseptata* Starb., on *Anthyllis*, Lechleiten ins Alpen, 1800 m., July 6, 1909, leg. Ade (Riksmuseet: Herb. Rehm).
315. *Pleospora alpestris* E. & E., on *Trollius laxus*, Cameron Pass, Colo., July, 1894, leg. C. S. Crandall (N.Y.B.G.: Ellis coll. No. *84*) (Type).
316. *Pleospora montana* Wehm., on *Lupinus candicans*, Togwotee Pass., Moran, Wyo., July 8, 1940 (Wehm. Herb. *1101*) (Type).
317. *Pleospora montana* Wehm., on *Lupinus* (*parviflorus?*), Togwotee Pass, Moran, Wyo., July 8, 1940 (Wehm. Herb. *1103*).
318. *Pleospora montana* Wehm., on *Lupinus candicans*, Togwotee Pass, Moran, Wyo., July 8, 1940 (Wehm. Herb. *1107*).
319. *Pleospora amplispora* E. & E., on *Lupinus*, Mt. Paddo, Washington, June, 1883, leg. W. N. Suksdorf (N.Y.B.G.: Fl. of Washington No. *74*) (Type).
320. *Pyrenophora gigantis* Clem., on *Lupinus ammophila*, Sulphur Springs, Colo., July 23, 1907 (Farl.: Clem. Crypt. Form. Colo. *448*) (Type).
354. *Clathrospora punctiformis* (Niessl) Berl., on *Agrostis* or *Aira*, Wald bei Königstein, July 1881 (Riksmuseet: Herb. Rehm).
527. *Pleospora rainierensis* Wehm., on Composite, Indian Henry's Hunting Ground, Mt. Rainier, 5500 ft., Aug. 3, 1948, leg. E. G. Simmons No. *1746d*.
528. *Pleospora laxa* Ell. & Holw., on *Potentilla flabellifolia*, Yakima Park, Mt. Rainier, Washington, 6400 ft., Aug. 18, 1948, leg. E. G. Simmons No. *1951*.
529. *Pleospora asymmetrica* Wehm., on *Festuca viridula*, Berkeley Park, Mt. Rainier, Washington, 6000 ft., Aug. 17, 1948, leg. E. G. Simmons No. *2188*.
530. *Pleospora rainierensis* Wehm., on *Muhlenbergia filiformis*, Indian Henry's Hunting Grounds, Mt. Rainier, Washington, 5300 ft., July 18, 1948, leg. E. G. Simmons No. *2209*.
530a. *Clathrospora Cookei* Wehm., associated with preceding.
531. *Pleospora asymmetrica* Wehm., on *Lupinus volcanicus*, Dege Peak Trail, Mt. Rainier, Washington, 6800 ft., Aug. 19, 1948, leg. E. G. Simmons No. *1937b*.
537. *Pleospora asymmetrica* Wehm., on *Agrostis* sp., Yakima Park, Mt. Rainier, Washington, 6400 ft., Aug. 18, 1948, leg. E. G. Simmons No. *2187*.
538. *Pleospora asymmetrica* Wehm., on *Muhlenbergia filiformis*, Indian Henry's Hunting Ground, Mt. Rainier, Washington, 5500 ft., Aug. 2, 1948, leg. E. G. Simmons No. *2200a*.
542. *Pleospora njegusensis* Bub., on *Balsamorrhiza sagittata*, Jackson Lake, Wyo., 6700 ft., June 25, 1948, leg. E. G. Simmons No. *1370*.
551. *Pleospora asymmetrica* Wehm., on grass, Van Trump Park, 5800 ft., Mt. Rainier, Washington, July 26, 1948, leg. E. G. Simmons, No. *2204* (Wehm. Herb.).
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DISTRIBUTION OF SPECIES OF SYNCHYTRIUM IN NORTH AMERICA

MELVILLE THURSTON COOK

(WITH 1 FIGURE)

About 95 species of the genus *Synchytrium* have been reported from the northern hemisphere. A few species have been reported from the southern hemisphere, mostly from South America. The descriptions of 43 species are incomplete but there is very little doubt, in most cases, that they belong in this genus. About 56 species (or 59 if we include the West Indies and Greenland) have been reported from North America, mostly from the United States. The descriptions of thirteen or more of these species are incomplete. Fourteen of the North American species were reported and described in Europe, one from South America, one from Costa Rica and one from Greenland. They are *Synchytrium andinum*,[1] *S. anemones*, *S. anomalum*, *S. aureum*, *S. australe*,[1] *S. boerhaaviae*,[1] *S. chrysosplenii*, *S. dolochi*,[1] *S. endobioticum*, *S. fulgens*, *S. globosum*, *S. groenlandicum*,[1] *S. myosotidis*, *S. plantageum*, *S. potentillae*, *S. stellaria*, *S. succisae*, and *S. taraxaci*. Most of the American species have been reported from the United States but a few have been found in Canada, Costa Rica, the West Indies and Greenland.

There are four prominent areas in the United States in which Synchytria have been studied, as follows: (1) The eastern area in which the states of Massachusetts, New York, Pennsylvania and New Jersey are especially prominent. This area has been studied by several mycologists. (2) The middle west area which includes the states of Wisconsin, Iowa, Michigan and Illinois contains many species and has been studied intensively by the late Dr. J. J. Davis.

[1] *S. andinum* Lag. (1895) from Ecuador, *S. australe* Speggazzini (1881) from Argentina, *S. dolochi* (Cooke) Gäumann (1927) from Africa, *S. groenlandicum* Allescher & Hennings (1897) from Greenland and *S. boerhaaviae* Speggazzini (1881) from Costa Rica.

(3) The southern area which contains more species than either of the preceding and has been studied intensively by the writer in recent years. (4) The Pacific Coast area which has been studied by several mycologists but not as intensively as the other areas. Very few species have been reported from other regions but undoubtedly will be found when these areas are studied.

SYNCHYTRIUM DECIPIENS [2] (Peck) Farlow (1885) has the greatest geographical distribution of any American species so far as known. It has been reported from several countries including Canada, Mexico, and Costa Rica, and from 29 states—Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, West Virginia, Virginia, North Carolina, Michigan, Wisconsin, Ohio, Indiana, Illinois, Kentucky, Tennessee, Alabama, Minnesota, North Dakota, South Dakota, Nebraska, Iowa, Kansas, Louisiana and Oregon. This species is very easily recognized and there is very little doubt as to the authenticity of these records. It has been reported from nearly all the states from the Atlantic Ocean to the Rocky Mountains.

SYNCHYTRIUM FULGENS Schroeter (1873) is a European species and has second widest distribution of any species found in North America. It has been reported from several countries and 23 states—New Hampshire, Massachusetts, New York, Pennsylvania, New Jersey, Delaware, Virginia, North Carolina, Michigan (?), Wisconsin, Ohio, Indiana, Illinois, Iowa, Nebraska, Oklahoma, Georgia, Alabama, Mississippi, Louisiana, Texas, Utah and California. It occupies an area almost as large as *S. decipiens*. This species is well defined and easily recognized but may be slightly different from the European species.

SYNCHYTRIUM AUREUM Schroeter (1870) is a European species and has been reported as attacking many species of host plants and has a very wide geographical distribution. It has been reported from several countries, from Canada and from 14 states—New Hampshire, Massachusetts, New York, Pennsylvania, Wisconsin, Illinois, Florida, Mississippi, Louisiana, Montana, Idaho, Utah, Oregon and California. There is a great deal of confusion con-

[2] *Synchytrium accioides* (Peck) Patouillard & Lagerheim (1891) is a synonym of *S. decipiens*.

cerning this species and it should be studied very carefully and revised.

SYNCHYTRIUM PLURIANNULATUM (Berk. & Curt.) Farlow (1885) is an American species that has been reported from European countries, from Canada and from 11 states—New York, New Jersey, Wisconsin, Illinois, Iowa, Alabama, Mississippi, Colorado, Oregon and California. The description is incomplete. It causes galls that have been attributed to *Urophyctis* by some students. The writer has found both *Synchytrium* and *Urophlyctis* on *Sanicula canadensis* but has not been able to separate them before sectioning.

SYNCHYTRIUM GLOBOSUM Schroeter (1870) is a European species that has been reported from 4 widely separated states—Massachusetts, Wisconsin, South Carolina and Louisiana.

SYNCHYTRIUM CINNAMOMEUM Davis (1924) is an American species that has been reported from Wisconsin and Iowa. The description is incomplete.

SYNCHYTRIUM ANEMONES (DC.) Woronin (1868) is a European species that has been reported from Canada and 9 states—Massachusetts, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Michigan, Wisconsin and Iowa. The description is incomplete.

SYNCHYTRIUM ANOMALUM Schroeter (1870) is a European species that has been reported from 7 states—Massachusetts, New York, Pennsylvania, Wisconsin, Iowa, Washington and California. Also from Puerto Rico and Santo Domingo. The description is incomplete.

SYNCHYTRIUM AUSTRALE Speggazzini (1881) is an Argentine species that has been reported from Europe and 4 states—Alabama, Louisiana, Texas and Kansas. The description is incomplete.

SYNCHYTRIUM GERANII Clendenin (1895) is an American species that has been reported from 4 states—Louisiana, Alabama, Texas and Oklahoma. It is well defined and easily recognized.

SYNCHYTRIUM CARICIS (T. & E.) Jones (1895) is an American species that has been reported from Utah and California. The description is incomplete.

SYNCHYTRIUM STELLARIAE Fuckel (1869) is a European species that has been reported from 7 widely separated states—Pennsyl-

vania, North Carolina, Mississippi, Louisiana, Missouri, Oklahoma and California. *S. chiltonii,* which has been described by the writer, is similar to *S. stellariae.*

SYNCHYTRIUM ASARI Arthur & Bailey and Holway (1886) is an American species that has been reported from Canada and 6 states—Massachusetts, Wisconsin, Illinois, Minnesota, Washington and California. The description is incomplete. Several herbarium specimens marked with this name that have been sent to the writer were rusts. *S. anomalum* has been reported on *Asarum canadense* in Wisconsin by Holway, on *A. reflexum* in Wisconsin by Davis and on *A. hartwegia* in Washington by Cooke. Are they the same as *S. asari?*

SYNCHYTRIUM VACCINII Thomas (1889) is an American species that has been reported from Canada (Nova Scotia and Newfoundland) and from 5 states—Maine, New York, Massachusetts, New Jersey and Michigan. It is well defined and easily recognized. The description is incomplete.

SYNCHYTRIUM TARAXACI deBary & Worowin (1865) is a European species that has been reported from 3 states—Wisconsin, Texas and Oregon.

SYNCHYTRIUM MYOSOTIDIS Kuhn (1868) is a European species that has been reported from 4 widely separated states—Massachusetts, Wisconsin, California and Arizona. The description is incomplete.

SYNCHYTRIUM HOLWAYI Farlow (1885) is an American species that has been reported from Iowa and Wisconsin. The description is incomplete.

SYNCHYTRIUM CELLULARE Davis (1919) is an American species that has been reported from 2 widely separated states—Wisconsin and Maine.

SYNCHYTRIUM PAPILLATUM Farlow (1878) is an American species that has been reported from 3 states—Oregon, California and Arizona.

SYNCHYTRIUM PLANTAGEUM Saccardo (1873) is a European species that has been reported from 3 widely separated states—Missouri, Mississippi, and Texas. The description is incomplete.

SYNCHYTRIUM SCIRPI Davis (1905) is an American species that

has been reported from 2 widely separated states—Wisconsin and New York. The description is incomplete.

SYNCHYTRIUM ANDINUM Lag. (1895) is a South American species that has been reported from Oregon and California. The description is incomplete.

The following species have been reported from one state only: *Synchytrium amsinckiae* McMurphy (1913) from California (may be closely related to *S. myosotidis*); *S. nigresens* Davis (1919) and *S. pulverum* Davis (1921) (may be the same as *S. cellulare*) have been reported from Wisconsin; *S. succisae* (deBary & Woronin) Schroeter (1897) from Illinois; *S. innominatum* Farlow (1885) (may be closely related to *S. taraxaci* deBary & Woronin (1865)), has been reported from California; *S. endobioticum* (Schilb) Perc. (1911) from Pennsylvania; *S. Jonesii* Peck (1880) (doubtful species) from Utah; *S. marrubia* (Farlow) Tobler (1878) (may be the same as *S. punctatum* Schroeter) from Massachusetts; *S. nitidum* Ellis & Galloway from Texas; *S. rugulosum* Dietel (1895) from California; *S. potentillae* [3] (Schroeter) Lagerheim (1889) from Massachusetts; *S. fragariae* [4] Zeller & Campbell (1949) from Oregon; and *S. groenlandicum* Allescher & Hennings (1897) from Greenland.

The writer has seen specimens of *Synchytrium ligustici* E. & E. (1894) and *S. polemonii* E. & E. (1894) from the state of Washington but they are apparently undescribed herbarium specimens in the Washington State College herbarium. *S. marginale* E. & E. from Texas and *S. perforatum* E. & E. from Washington are undescribed specimens in the herbarium of the New York Botanical Garden.

Synchytrium chrysosplenii Sorokin (1872) has been described from Switzerland on *Chrysoplenium alternifolium*. The writer has material that was collected at Ithaca, New York, which was supposed to be the same. The description is incomplete.

The following species have been described by the writer from material collected in Louisiana: *Synchytrium modioliensis, S. chiltonii, S. cerastii, S. edgertonii, S. lepidii, S. hydrocotyles, S. eri-*

[3] Also reported from Mexico.

[4] This is the only species of *Synchytrium* reported on the roots of plants.

gerontis, S. stachydis, S. lythri, S. oxalidis, S. ranunculi, S. sambuci, S. impatentis, and *S. smilaxium.*

Synchytrium aureum has been reported on *Hydrocotyle americana; S. australe* has been reported on *Modiola prostata* in Argentina and on *Modiola multifida* in France. I believe that *S. modiolensis* Cook, in Louisiana, is different.

Synchytrium abnorme Spegazzini (1909) has been reported on *Cerastium vulgatum* in Argentine. The description is incomplete and is different from that of *S. cerasti* Cook.

S. decipiens, S. anemones, S. aureum, S. pluriannulatum, S. ascari and *S. vaccinii* have been reported from Canada; *S. decipiens* and *S. boerhaaviae* from Costa Rica; *S. dolochi* from Puerto Rico, Santo Domingo and St. Croix; *S. anomalum* from Puerto Rico and Santo Domingo; *S. decipiens* or a species closely related to *S. potentillae* from Mexico; *S. groenlandicum* from Greenland.

A study of the distribution indicates that most or possibly all species found in America have a much wider geographical distribution than has been reported.

Of all the 56 species recorded in this paper, 40 species occur on one host species only, 6 species on two host species, 4 species on three host species, 2 species on four host species, one species on six host species, one species on seven host species and seven species on many species of host plants. A study of the literature indicates that most species attack but one species of host plant, that a few attack two species of host plants and a very few attack more than two species of host plants. Very few, if any, attack species in more than one family.

The writer does not question the authenticity of the reports of parasitism of any of the European species except *Synchytrium aureum,* which has been reported as attacking 197 species, in 127 genera and in 31 families. It is doubtful if this species attacks so many species of host plants, or genera or families. The writer has examined several infected American specimens on which *S. aureum* has been reported. All of them differ from the descriptions by DeCondolle and Woronin, except the one on *Lactuca* sp. which corresponds with the original description and to the drawings by Rytz (1907). The writer believes that many distinct species have been included in *S. aureum.*

Studies on herbarium material by the writer lead to the opinion that a considerable number of specimens in American herbaria have been incorrectly determined. In some cases the writer suspects that the material may have been assigned to certain host species because it was found on what was supposed to be the same species or species in the same genera of host plants and without careful



FIG. 1. Showing the number of species reported from each state.

study. A study of the drawings of a few species has been very satisfactory. The studies were probably made from a very few free hand sections.

The color of the fungus is of very little value in writing descriptions or in making determinations of species. The color varies with age. The few zoospores observed by the writer have been hyaline. The fungus in many species studied by the writer has been light lemon-yellow when young, gradually becoming darker yellow, orange and in some cases quite dark with age. In *S. decipiens,* which persists throughout the summer, the fungus in material collected late in the summer was much darker than that collected earlier.

The four characters most satisfactory for describing, classifying and determining species are the structure of the galls, the size of

the fungus, the formation of the zoosporangia and the number of sporangia. The structure of the galls varies to some extent with the location on the plant and sometimes on the part of the leaf on which it occurs but is quite constant in most cases.

The writer has made his studies from fresh material and from material embedded in paraffin. The fresh material enabled the writer to follow the changes in color of the fungus and the paraffin sections enabled him to follow the development and final structure of the galls. The shape and structure of the galls and their relationship to the host tissues are more reliable than any other characters.

Species that have been described in Europe and found later in America should be studied again very carefully. The fact that they occur on the same or related host plants is no evidence that they are the same. Species in distant countries and supposed to be the same as those described first in America should be studied with equal care. The writer is of the opinion that we are not justified in the conclusion that a species found in one part of the world is the same as a species on the same or a related host plant in another part of the world.

The writer is of the opinion that no satisfactory description can be prepared without studies of sections, preferably of material embedded in paraffin. The writer wishes to study European species that have been reported from America. This material should be preserved in such a manner that it can be embedded or embedded before it is sent to me. It is hoped that the study of such material will enable us to decide definitely if some of our American species are the same as those found in Europe.

The writer wishes to express his thanks to American botanists for reports on herbarium material and other assistance in preparing this paper.

DEPARTMENT OF BOTANY,
LOUISIANA STATE UNIVERSITY,
BATON ROUGE, LOUISIANA

NEW GENERA OF FUNGI. V [1]

ROLF SINGER

A group of new species all closely related with each other and with the genera *Armillariella, Omphalina,* and *Pleurocybella,* was found in the region of the Selva Boliviano-Tucumana on Argentine territory. These species are thus far the only ones which do not fit into the scheme outlined in my recent book,[2] whereas almost 2000 collections from other South American stations including Brazil, Tierra del Fuego, Chile, Paraguay, Uruguay, Bolivia and Perú neatly fitted into the classification established by the author on the basis of previous studies.

These three "rebellious" species differ from *Armillariella* in having somewhat thick-walled hyphae and consequently more elastic-toughish consistency; they combine lignicolous habit with absence of veil and rhizomorphs; one of these species appears to be even more aberrant because of the presence of clamp connections. The hymenophoral trama is strongly irregular as in the genus *Pleurocybella* (Mycologia **39**: 81. 1947) but this latter genus is characterized by the absence of pigmentation and by very short spores whereas the three new species have a strong intracellular pigmentation, the pigment being dissolved in the cell sap, and elongate spores; the stipe is practically absent in the type species of *Pleurocybella* and the lamellae consequently not decurrent and in a species ranged in *Pleurocybella* with some reservations, the stipe is eccentric and the lamellae adnato-subdecurrent; in the new South American species, the stipe is central or very slightly subeccentric. One of these species has markedly omphalioid habit but differs strongly from *Omphalina*—as do the other two—

[1] The earlier parts of this series have been published in Mycologia **36**: 358–368. 1944; II: Lloydia **8**: 139–144. 1945; III: Mycologia **39**: 77–89. 1947; IV: Mycologia **40**: 262–264. 1948.

[2] Singer, Rolf. The Agaricales in Modern Taxonomy, published in Lilloa, vol. 21, 1949 (1951). (Publications of the Instituto M. Lillo, Tucumán, Argentina.)

in several important characters, *viz.*, in constantly intracellular pigment, in more toughish consistency, in narrow lamellae, and in the absence of the intercellular granulosity staining blue in methylene blue as indicated by Romagnesi (Bull. Soc. Myc. France **58**: 82. 1942). Other genera that might be compared are *Nothopanus* and *Clitocybe*, the former differing in appearance, short, or wanting stipe, and broad lamellae which are never found to be deeply decurrent; *Clitocybe* differs in having quite regular gill trama, only rarely becoming slightly subirregular, with hyphae that often diverge in the outermost stratum of the hymenophoral trama and have thin walls; furthermore, the species of *Clitocybe* which grow on wood differ strongly in habit and color; all species of *Clitocybe* have clamp connections. One may also add that the genera *Omphalina* and *Pleurocybella* have a clearly different geographic area, being northern-temperate, rarely also represented in the antarctic and subantarctic zone and the high mountains of the subtropical zones but always showing a distinct tendency to be boreal or montane. At the same time, the three Argentine species under consideration are typical inhabitants of the "selva," *i.e.*, tropical to subtropical rain forests where they grow during the summer rains, *i.e.*, the hottest period of the year.

Therefore, a new genus is here proposed to accommodate the three new species mentioned above:

Gerronema gen. nov. Habitu omphalioideo vel *Clitocybis* cuiusdam minoris tenuis, elongatae; pileo partim vel ex toto pigmentato; pigmento intracellulari, dissoluto, abundante; cuticula ex hyphis repentibus efformata; lamellis decurrentibus, angustis; cystidiis nullis; sporis in cumulo albis; sporis levibus, hyalinis, haud amyloideis, elongatis, mediis; tramate hymenophorali irregulari; hyphis fibulatis vel defibulatis, inamyloideis, crassotunicatis vel subcrassotunicatis; stipite centrali vel vix excentrico, elongato; carne alba, elastico-tenacella; habitat ad lignum putridum, rarius ad humum lignosum in silva subtropicali. Species typica: *Gerronema melanomphax* Sing.

Gerronema elasticum Sing. spec. nov. Characteribus generis; fibulis praesentibus; habitat ad lignum emortuum, Anta Muerta, Tucumán, Argentina.

Pileus fuliginous-grey, "acorn" (Maerz & Paul, as all quotations within quotation marks in the following description) with deeper colored margin and paler center, or almost unicolorous, not or not distinctly hygrophanous, initially with an umbilicus of "par-

tridge" color, the central zone eventually infundibuliform, the marginal zone convex, later flattened, or else the entire pileus infundibuliform when mature, glabrous but indistinctly to distinctly striped because of an innate radiate fibrillosity, often slightly rimulose in the center, with smooth margin which may become slightly split when drying, otherwise entire, smooth and naked everywhere, 20–30 mm. broad. Lamellae white, in dried material sometimes very slightly greyish pallid, strongly decurrent, arcuate, close to moderately close, strongly venose-anastomosing, with numerous lamellulae regularly intermixed, narrow (2 mm. broad); spore print white. Stipe white with fuliginous longitudinal stripes, or concolorous with the pileus but with white apex, finely flocculose-fibrillose, pruinate, or glabrous, equal or tapering upwards, with thickened base if otherwise equal, central or slightly subeccentric, 22–55 × 2–3 mm. (above), 3–4 mm. broad below; basal tomentum strigose and white to grey. Context white, unchanging, somewhat toughish and distinctly elastic; odor none; taste mild.

Spores 8.5–10.2 × 5.5–6.2 μ, broader near the hilar end, subellipsoid, sometimes attenuate at the apex, but the latter always broadly rounded, smooth, rather thin-walled, or very thin-walled, usually without distinct suprahilar applanation or depression, non-amyloid; basidia (22)45–48 × 8–9 μ (*i.e.* rather long), without carminophilous granulation, clavate, 4-spored; cystidia none except for a few pseudoparaphyses which do not differ from the basidioles but for their "empty" appearance and permanent sterility; basidioles filamentous-cylindric; subhymenium consisting of interwoven, dense hyaline hyphae with thin walls and of small size; hymenophoral trama hyaline, irregular, consisting of almost intermixed unequal hyphae with thickened walls (up to 1 μ in diameter), rather dense but the hyphae not intricately interlaced, with no more than a trace of predominant axillar arrangement (almost regular at certain places near the edge in the outer stratum) when young but soon becoming as irregular as in *Pleurotus ostreatus;* cuticle of the pileus consisting of hyphae which are radially arranged, repent, with intracellular dissolved brownish pigment, smooth, forming a cutis; all hyphae non-amyloid, with clamp connections, with slightly to distinctly thickened walls (1 μ).

On rotten wood and fallen branches in the subtropical forests near the upper fringe of the *Phoebe*-association, growing fasciculately (up to 6 specimens in one fascicle), fruiting from December until March.

Material studied: ARGENTINA, Tucumán, Anta Muerta, 1100 m. alt., December 19, 1949, R. Singer, no. *T 786*, LIL. March 26, 1950, R. Singer, no. *T 944*, LIL. No. *T 786* is the type.

Gerronema elasticum is a characteristic species. It has somewhat the appearance of *Cantharellula coprophila* (Speg.) Sing. which occurs in the neighborhood of the type locality, but when the innate fibrillosity of the pileus is well developed, one may be inclined to guess it belongs to *Fayodia*. It differs sharply from both *Cantharellula* and *Fayodia* in non-amyloid spores. This species may have been described by J. Rick under the name of *Omphalia elastica* Rick from Southern Brazil. The description agrees perfectly well, but no specimens have been seen.

Gerronema depauperatum Sing. spec. nov. Characteribus suis speciei praecedenti simillimum a qua autem absentia fibularum differt. Habitat ad truncos emortuos, Santa Rosa, Tucumán, Argentina.

Pileus fuscous, hygrophanous, grey when dry, slightly radially fibrillose from innate fibrils, convex with deeply and acutely umbilicate center even when quite young, up to 23 mm. broad. Lamellae pallid white, almost glassy, later greyish white, rather distant, decurrent, descendant, narrow (1–1.7 mm.), not or not strongly anastomosing; spore print white. Stipe at first white, later greyish white or grey-pallid, subglabrous or glabrous, canaliculate, at first subequal, with slightly attenuate base, later often with slightly thickened base, sometimes curved but centrally attached, elongate. Context white and unchanging or slightly staining pale yellow in age when drying (as there is a tendency to become light citron yellow, even on the surfaces, without being touched or wounded), somewhat tough in the stipe, elastic; odor none; taste mild.

Spores 6.8–11 × 3.5–4.8 μ, mostly 6.8–7.5 × 4–4.2 μ, but also more elongate (to 11 × 3.5 μ) or more voluminous, *e.g.* 11 × 4.8 μ, variable in shape, smooth, thin-walled, non-amyloid; basidia 29–35 × 6.8–8.2 μ, with 1, 2, 3, or 4 sterigmata, clavate; cystidia none; subhymenium consisting of small filamentous elements which ramify and are not strongly differentiated from the lateral portion of the hymenophoral trama; hymenophoral trama with a broad central strand which is interwoven and even subintermixed, consisting of some very broad and numerous thin to medium thick hyphae, many of which are thick-walled; lateral strand gradually more regular or subdivergent as in *Clitocybe*, with the hyphal elements more thin-walled than in the central strand; epicutis consisting of

hyphae which are repent, rather thin, radially arranged, with all the pigment intracellularly dissolved, with smooth walls; hyphae of the pileus and stipe intermixed with numerous connective hyphae, the fundamental hyphae often decidedly thick-walled, without clamp connections, non-amyloid, without incrusting granulation staining blue in methylene blue mounts.

On dead trunks in the upper region of the *Phoebe*-association of the rain forest, in small crowded groups, or solitary, fruiting in summer.

Material studied: ARGENTINA, Tucumán, Santa Rosa along Rio de las Pavas, December 17, 1950, R. Singer, *T 1067* LIL, type.

This species differs from the preceding one in lacking clamp connections and in a large number of basidia with less than 4 sterigmata. It also differs macroscopically in having a tendency to become partly citron yellow in age, in having a more hygrophanous pileus and less anastomosing lamellae which are also more distant on an average. Nevertheless, the affinity is obvious. In taxonomy, there is no greater danger than schematic or dogmatic thinking. It would be more convenient than natural to combine *G. elasticum* with *Pleurocybella* in an emended interpretation, and *G. depauperatum* with *Armillariella*. Yet, the two species are obviously too closely related to permit such an easy solution. There is no reason to believe that a character of enormous importance in the Agaricales (as has been demonstrated by this author at several occasions) should not at times be no more than a specific character. There is a precedence in this very subtribus—Tricholomatinae—where we have refrained from separating the species of *Tricholoma* with clamped septa from those without clamp connections unless they are separated from the main group by other important character combinations. Even in the closely related genus *Armillariella*, the base of the basidia is often clamp-bearing in certain species while the hyphae are clamp-less. There is evidently a process of evolution still in progress tending towards the loss of the clamp connections at this level. *Gerronema* represents the line leading from *Pleurocybella* into the clampless group (Tricholomatinae).

Gerronema melanomphax Sing. spec. nov. Pileo papilla centrali atra praedito, extus albo; lamellis albis, distantibus, subangustis, decurrentibus; stipite albo, glabro, filamentoso; sporis 7.2–9.5 × 4.7–5.5 μ, guttiformibus vel

cylindraceis vel ellipsoidalibus; basidiis tetrasporis; pigmento papillae pilei intracellulari; fibulis nullis; habitat ad lignum putridissimum vel ad humum lignosum prope Los Sosas, Tucumán, Argentina.

Pileus white, with deep fuscous to blackish fuscous disc, glabrous, smooth, dry, convex and umbilicate with a central papilla in the umbilicus, 12–13 mm. broad. Lamellae white, distant, rather narrow, decidedly decurrent, arcuate to almost descendant; spore print white. Stipe white, glabrous, smooth, naked, equal, 23–24 × 1–1.7 mm. Context white, unchanging, elastic-toughish, inodorous.

Spores 7.2–9.5 × 4.7–5.5 μ, guttiform, cylindric, or ellipsoid, smooth, thin-walled, non-amyloid; basidia 19–38 × 4.8–7.5 μ, 4-spored, few 2-spored, clavate; cystidia none, not even cheilocystidia or prominent pseudoparaphyses differentiated; subhymenium ramose-filamentous, consisting of short and thin elements which are moderately well differentiated from the outer layer of the hymenophoral trama; hymenophoral trama consisting of a broad central strand which is more intermixed and quite irregular, with numerous very broad elements, and an outer layer which is somewhat more axillarily arranged and consists of somewhat thinner elements, almost all elements of the trama somewhat to distinctly thick-walled, the walls 0.4–1.0 μ in diameter; epicutis consisting of repent hyphae forming a cutis, radially arranged and filamentous, the outermost layer with hyphae of somewhat smaller diameter than those of the poorly developed hypodermium; hyphae of the pigmented portion (papilla) with deep fuscous intracellular, dissolved pigment, without incrustation, the outermost hyphae sometimes very slightly roughened or wavy but by no means diverticulate; all hyphae non-amyloid, without clamp connections, without external granulation in methylene blue mounts.

On very rotten wood and woody humus, solitary in subtropical forest, fruiting in summer.

Material studied: ARGENTINA, Tucumán, near Los Sosas, January 1, 1951, R. Singer, *T 1094*, LIL, type.

This species is macroscopically very characteristic because of its dark papilla contrasting strongly with the otherwise white pileus, and its *Omphalina* habit. Yet it is different from the true Omphalinae because of its consistency, narrower lamellae, intracellular pigment and lack of granulation in methylene blue. Aside from that, the rain forest in its lower subtropical belt is completely devoid of the montane boreal and antarctic species, consequently of all true Omphalinae, at least in the western hemisphere, and according to

our observations up to this date. Nevertheless, there can be no doubt but that *Gerronema*, and especially *G. melanomphax*, is close to the genus *Omphalina*. As in *Omphalina*, we have clamped and clamp-less species in *Gerronema*.

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MANUSCRIPT

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